

AD-A170 298

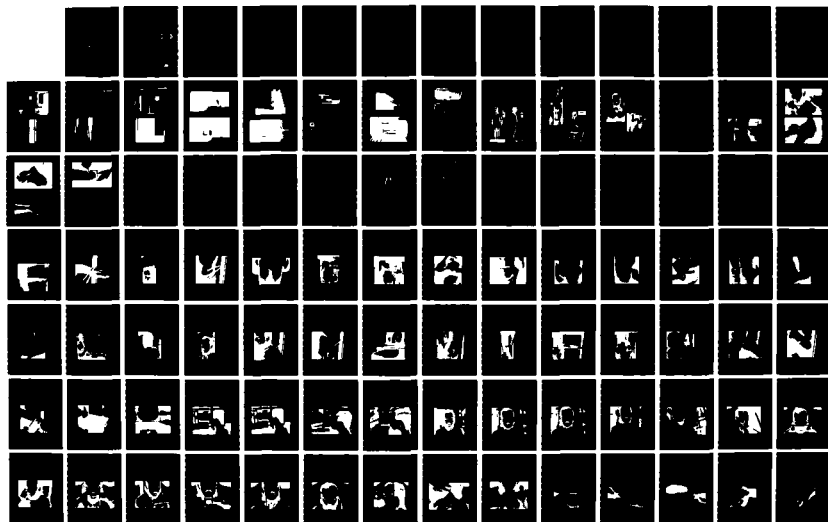
ANTHROPOMETRY HANDBOOK(U) SCHOOL OF AEROSPACE MEDICINE  
BROOKS AFB TX P H GILL FEB 86 USAFSAM-TR-85-108

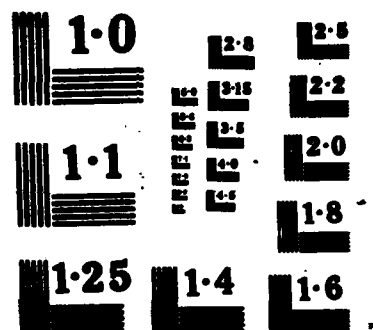
1/2

UNCLASSIFIED

F/G 6/14

NL





12

USAFSAM-TR-85-108

## ANTHROPOMETRY HANDBOOK

Peter H.R. Gill, Wing Commander, RAF

DTIC  
ELECTE  
JUL 25 1986  
S D

February 1986

Final Report for Period September 1982 - March 1984

Approved for public release; distribution is unlimited.

USAF SCHOOL OF AEROSPACE MEDICINE  
Aerospace Medical Division (AFSC)  
Brooks Air Force Base, TX 78235-5301



86 4 22 075

AD-A170 298

DTIC FILE COPY

## NOTICES

This final report was submitted by personnel of the Crew Systems Branch, Crew Technology Division, USAF School of Aerospace Medicine, Aerospace Medical Division, AFSC, Brooks Air Force Base, Texas, under job order 7930-11-76.

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the United States Government incurs no responsibility nor any obligation whatsoever. The fact that the Government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

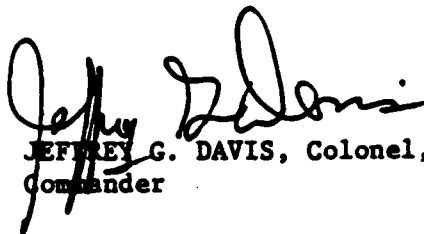
This report has been reviewed and is approved for publication.



CHARLES D. CAULKINS, Capt, USAF, BSC  
Project Scientist



JOHN B. BOMAR, Jr., Col, USAF, BSC  
Supervisor



JEFFREY G. DAVIS, Colonel, USAF, MC  
Commander

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD 4170 298

## REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAFSAM-TR-85-108			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION USAF School of Aerospace Medicine		6b. OFFICE SYMBOL (If applicable) USAFSAM/VNL		7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State, and ZIP Code) Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas 78235-5301			7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION USAF School of Aerospace Medicine		8b. OFFICE SYMBOL (If applicable) USAFSAM/VNL		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code) Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas 78235-5301			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO. 62202F	PROJECT NO. 7930	TASK NO. 11
11. TITLE (Include Security Classification) ANTHROPOMETRY HANDBOOK					
12. PERSONAL AUTHOR(S) Gill, Peter H.R.					
13a. TYPE OF REPORT Final Report		13b. TIME COVERED FROM Sep 82 TO Mar 84		14. DATE OF REPORT (Year, Month, Day) 1986, February	
15. PAGE COUNT 109					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Anthropometry; Body Size; Measurements; Equipment Development; Integration; Research and Development; Equipment Design; and Specifications.		
FIELD	GROUP	SUB-GROUP			
06	14				
14	02				
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report details the rationale (techniques and equipment used, and specific body measurements recommended) for the use of an anthropometry laboratory and body size measuring equipment which have been constructed to support the development of a comprehensive Cockpit and Equipment Integration Laboratory.					
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL Peter H.R. Gill, Wing Cdr, RAF			22b. TELEPHONE (Include Area Code) (512) 536-2548		22c. OFFICE SYMBOL USAFSAM/VNL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.

All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

# CONTENTS

	<u>Page</u>
INTRODUCTION . . . . .	1
Apparatus. . . . .	1
Choice of Measurements . . . . .	1
APPARATUS . . . . .	1
Body Measuring Rig. . . . .	1
Head Measuring Rig. . . . .	2
Head Caliper. . . . .	3
Body Width Caliper. . . . .	3
Foot Measuring Box. . . . .	3
Measuring Tapes. . . . .	3
Knee Block . . . . .	3
Body Marking Template. . . . .	3
Waist Belt . . . . .	3
Weighing Scales. . . . .	4
Standard Anthropometer . . . . .	4
Calibration of Apparatus. . . . .	4
SUMMARY OF TERMS AND DEFINITIONS . . . . .	12
Postures . . . . .	12
Measurement Terms . . . . .	13
Body Marks . . . . .	16
Anatomical Terms . . . . .	20
DEFINITION OF MEASUREMENTS . . . . .	28
Subject Information . . . . .	28
Body Measurements . . . . .	28
BODY MEASUREMENTS - STANDING. . . . .	32
BODY MEASUREMENTS - SITTING . . . . .	48
BODY MEASUREMENTS - HEAD/NECK . . . . .	64
BODY MEASUREMENTS - HANDS/FEET . . . . .	84
BODY MEASUREMENTS - DERIVED MEASURES. . . . .	92
ACKNOWLEDGEMENTS. . . . .	93
REFERENCES. . . . .	93
APPENDIX: TABLES OF MEASUREMENTS . . . . .	95

<input checked="" type="checkbox"/>	
<input type="checkbox"/>	
<input type="checkbox"/>	
Codes	
Major or	
Sub	



A-1

## FIGURES

<u>Fig. No.</u>		<u>Page</u>
1.	Plan diagram of the anthropometry rig. . . . .	4
2.	General view of measuring rig . . . . .	5
3.	Illustration of datum probe and vertical scale. . . . .	5
4.	Illustration of horizontal scale . . . . .	6
5.	Illustration of sloping mirror . . . . .	6
6.	Full view of measuring rig . . . . .	7
7.	Illustration of fixed wall mirror . . . . .	7
8.	Illustration of floor markings . . . . .	8
9.	Illustration of stool . . . . .	8
10.	Head measuring rig . . . . .	9
11.	Head and body calipers. . . . .	9
12.	Foot measuring box . . . . .	10
13.	Measuring tapes, waist belt, and body marking template . . . . .	10
14.	Knee block . . . . .	11
15.	Standard anthropometer and ancillary equipment. . . . .	11
16.	Anthropometer and ancillary equipment. . . . .	12
17.	Illustration of standing position . . . . .	13
18.	Illustration of sitting posture. . . . .	14
19.	Illustration of head rig posture . . . . .	15
20.	Diagram of body marks . . . . .	17
21.	Illustration of waist mark . . . . .	17
22.	Illustration of shoulder mark . . . . .	18
23.	Illustration of acromial mark . . . . .	18
24.	Illustration of cervicale mark . . . . .	19

<u>Fig. No.</u>		<u>Page</u>
25.	Illustration of wrist mark. . . . .	19
26.	Illustration of knee mark . . . . .	20
27.	Anatomical planes and orientations . . . . .	24
28.	Anatomical and anthropometric landmarks (front view) . . . . .	25
29.	Anatomical and anthropometric landmarks (side view) . . . . .	26
30.	Anthropometric landmarks of the head and face (front view) . . . . .	27
31.	Anthropometric landmarks of the head and face (side view) . . . . .	27
32.	Anthro data record form. . . . .	29
33.	Diagram of body measures - standing. . . . .	30
34.	Diagram of body measures - sitting . . . . .	30
35.	Diagram of body measures - head/neck . . . . .	31
36.	Diagram of body measures - hands/feet . . . . .	31
37.	Elbow - fingertip length . . . . .	33
38.	Elbow - wrist length. . . . .	34
39.	Stature . . . . .	35
40.	Waist height . . . . .	36
41.	Crotch height . . . . .	37
42.	Vertical trunk circumference . . . . .	38
43.	Chest circumference . . . . .	39
44.	Elbow fully bent circumference . . . . .	40
45.	Waist circumference . . . . .	41
46.	Buttock circumference . . . . .	42
47.	Thigh circumference . . . . .	43
48.	Knee fully bent circumference. . . . .	44
49.	Lower thigh circumference . . . . .	45
50.	Calf circumference . . . . .	46



<u>Fig. No.</u>		<u>Page</u>
51.	Ankle circumference. . . . .	47
52.	Buttock - heel length . . . . .	48
53.	Cervicale height. . . . .	49
54.	Sitting height . . . . .	50
55.	Mid - shoulder height . . . . .	51
56.	Acromial height . . . . .	52
57.	Elbow rest height . . . . .	53
58.	Bi - deltoid breadth . . . . .	54
59.	Vertical functional reach. . . . .	55
60.	Functional reach. . . . .	56
61.	Chest depth . . . . .	57
62.	Abdominal extension to wall (stomach depth). . . . .	58
63.	Thigh clearance height. . . . .	59
64.	Knee height . . . . .	60
65.	Buttock - knee length . . . . .	61
66.	Stool height . . . . .	62
67.	Hip breadth . . . . .	63
68.	Tragion - vertex length . . . . .	64
69.	Tragion - wall length . . . . .	65
70.	Glabella - vertex length . . . . .	66
71.	Glabella - wall length (head length) . . . . .	67
72.	Pupil - vertex length . . . . .	68
73.	Sellion (nasion) - vertex length . . . . .	69
74.	Sellion (nasion) - wall length . . . . .	70
75.	Menton - vertex length. . . . .	71
76.	Menton - wall length . . . . .	72

<u>Fig. No.</u>		<u>Page</u>
77.	Maximum head diagonal (Menton to occiput). . . . .	73
78.	Head breadth . . . . .	74
79.	Bi - trasion breadth. . . . .	75
80.	Bi - ocular breadth . . . . .	76
81.	Bi - zygomatic breadth (face breadth) . . . . .	77
82.	Lip length . . . . .	78
83.	Menton - sub-nasale length. . . . .	79
84.	Head circumference . . . . .	80
85.	Bi - trasion coronal arc . . . . .	81
86.	Posterior neck length . . . . .	82
87.	Neck circumference . . . . .	83
88.	Hand breadth . . . . .	84
89.	Forefinger length. . . . .	85
90.	Finger length, digit 3 . . . . .	86
91.	Wrist circumference . . . . .	87
92.	Hand circumference . . . . .	88
93.	Foot length. . . . .	89
94.	Foot breadth . . . . .	90
95.	Ball of foot circumference. . . . .	91

## TABLES

<u>Table No.</u>		
A-1.	Alphabetical Index of Measurements. . . . .	96
A-2.	Numerical Index of Measurements. . . . .	99

## ANTHROPOMETRY HANDBOOK

### INTRODUCTION

To support the development of a comprehensive Cockpit and Equipment Integration Laboratory, an anthropometry laboratory has been constructed based on the design used by the Royal Air Force Institute of Aviation Medicine, Farnborough. This report details the rationale for the use of the anthropometry laboratory and the body size measuring equipment.

#### Apparatus

The body measurement rig was designed to enable body measurements to be taken more easily and with repeatable accuracy, so as to reduce fatigue in both subject and operator (measurer). Ancillary measuring equipment was also developed in addition to the main anthropometry rig.

#### Choice of Measurements

The measurements detailed later in this handbook were chosen to cover the following requirements:

- a. Selection of subjects suitable for use in the integration laboratory methodologies.
- b. Design analysis of aircrew clothing and personal equipment.
- c. Integration assessment of aircrew Personal Protective Equipment (PPE) and the cockpit workspace.

In all, 65 measurements have been chosen to represent the major parameters of body and body segment definition. Should additional measures be required, subjects may be recalled and further measurements taken.

For additional information concerning the integration laboratory methodologies, refer to Sears et al., USAFSAM-TR (In preparation).

### APPARATUS

A corner area of the Cockpit and Equipment Integration Laboratory has been fitted out as an anthropometric laboratory, and all measuring equipment installed therein. The plan of the laboratory is illustrated in Figure 1. The area is sufficient in size to provide space for a screened changing area together with a table and chair for the recording of the data.

#### Body Measuring Rig

The body measuring rig (Fig. 2) consists essentially of an end wall, a back wall, and a floor mutually at right angles. A vertical track, parallel to the end wall, slides in horizontal tracks at the top and bottom of the rear wall. A carriage slides in the vertical track and carries a datum probe. The probe (Fig. 3) can be rotated through four 90-degree "stops" so that the datum face is either parallel with the floor for measuring heights or parallel with

the end wall for measuring widths. On the carriage and at the top of the vertical track are vernier scales with 2-mm divisions (Fig. 4) which are read against scales of centimeters on the vertical track and at the top of the rear wall. This open scale system permits easy, rapid and direct reading to the nearest millimeter of the distance of the probe from either the end wall or the floor. The verniers can be adjusted for calibration. Two mirrors are incorporated in the rig. One is behind a perspex panel set in the end wall (Fig. 5) and has its base near the bottom of the end wall and is held at approximately 20 degrees from the vertical. This mirror enables the measurer to check body pressure against the end wall by monitoring the area of flesh flattened against the perspex panel. The second mirror is set into the rear wall of the rig (Fig. 6) and is used to monitor the run of the tape around the subject's back when measuring some body circumferences. A third mirror is mounted on the wall of the laboratory opposite the measuring rig (Fig. 7) so that the subject can look into the reflection of his own eyes to ensure a level horizontal gaze when sitting height measures are being taken. A fourth mirror is also mounted on the laboratory wall opposite the head measuring rig (Fig. 2) so that the subject can look into the reflection of his own eyes when head measurements are taken. The walls of the rig are Formica faced for ease of cleaning and the floor is covered with granulated sheet cork for the benefit of the barefoot subjects. Three different color pairs of footprints and three different color marking strips have been painted on the floor (Fig. 8) to reduce the amount of spoken instructions necessary to position the subject where required, and to standardize the positioning of subjects prior to measurements being taken. A cross shows where to sit for buttock - heel length measurement which is accomplished with a sliding block (Fig. 8) against a scale inset in the front edge of the rig floor.

The whole measuring rig area is lit by fluorescent tubes to ensure adequate visibility. A hydraulic jack mounted on a square wooden base and having a hard, flat, square, plastic covered top sitting platform is used as an adjustable height stool (Fig. 9). Lower limb circumference measurements are taken for convenience with the subject standing on the stool.

#### Head Measuring Rig

The head measuring rig (Fig. 10) is mounted on a vertical track on the outer edge of the end wall of the main measuring rig (Fig. 6). It is counter weighted and can be locked at any required height by means of cam locks. The rig consists of a vertical back plate and horizontal roof plate of half-inch perspex, the inner surfaces of which are the datum faces. A horizontal probe slides in a carrier suspended from the roof on two pairs of parallel motion arms jointed so that a moving scale attached to the carrier is always vertical and crosses at right angles a scale along the edge of the roof panel. The datum edge of the probe is formed by the intersection of two datum faces at right angles to each other at the centerline of the probe spindle. One of the mirrors in the main rig is used to ensure a consistent head attitude during the head measuring sequences. When the subject's head is aligned and in light contact with the back of the head box, the rig is lowered gently on its track until the top of the head box firmly contacts the head of the seated subject and is then locked in position. The probe is then traversed to contact the required head feature and its distance from the rig datum faces is read directly from the appropriate scales.

### Head Caliper

The head caliper (Fig. 11) consists of a beam with two arms perpendicular to it. One of these is mounted at the end of the beam and is fixed in position; the second arm, which is mounted on a spring-loaded carriage, slides along the beam over the full scale graduation. Each of the two arms carries a measuring pad which may be rotated through 180 degrees according to whether a flat disc (40 mm in diameter) or a ball end (6 mm in diameter) is required. Fine adjustments of the sliding arm are made with a knurled thumb wheel.

### Body Width Caliper

The body width caliper (Fig. 11) is similar in design to the head caliper except that the arms each carry a perspex datum face (230 mm x 90 mm).

### Foot Measuring Box

The foot measuring box (Fig. 12) consists of a base with two vertical walls forming a right angle. Two blocks slide in channels with their datum faces parallel to their opposing walls, which have the zero points of the appropriate centimeter scale for each datum face. A vernier scale with 2-mm divisions is mounted on each block.

### Measuring Tapes

Two glass cloth tapes (Fig. 13), each 10-mm wide, are used for measuring circumferences and some body segment measurements. The tape used for head and body measurements is 1.5 m in length with brass tab ends. The other tape, used only for vertical trunk circumference measurements, is 2 m in length with a rectangular metal loop attached to the zero end of the tape through which the free end of the tape is passed.

### Knee Block

Two perspex blocks, the smaller of which is 75 mm long, are joined at right angles to form the knee block (Fig. 14). The knee block is used to mark a position on the upper thigh 75 mm proximal to the front of the knee cap and is placed on the knee with the long face aligned with the shin. The short extension of the long face is used as the datum for measuring buttock - knee length.

### Body Marking Template

The template (Fig. 13) used for the shoulder and waist marks (see body marks definitions) is made from perspex sheet. It has two arms, the inner edges of which are 180 mm apart; the midpoint of the template is clearly engraved.

### Waist Belt

The 20-mm wide Velcro waist belt is shown in Figure 13. It is used to delineate the level of the waist circumferentially around the body.

## Weighing Scales

A platform electronic weighing machine is used for recording body weight to the nearest half kilogram.

## Standard Anthropometer

A Perceptronics Human Factors Engineering instrument package (Figs. 15 and 16) is available for carrying out ergonomic assessments of body working postures and aircraft cockpit workspaces. This kit includes a precision anthropometer, spreading calipers, sliding calipers, goniometer and measuring tapes. If required, a Harpenden skinfold caliper is available for the measurement of skinfold thickness.

## Calibration of Apparatus

Both the vertical and horizontal scales of the body measuring rig have been calibrated using the standard anthropometer, and should be recalibrated periodically. In the case of any discrepancies adjustment was made by moving the appropriate vernier scale. The probe was also checked for alignment by measuring vertically from the floor to the datum edge of the probe at various distances from the end wall along the length of the rear wall. The glass cloth tapes were also checked against the standard anthropometer. Weights (25 kg) were used to check the weighing machine. All moving parts of the equipment should be lubricated periodically. The tapes and all rig surfaces should be kept clean and disinfected.

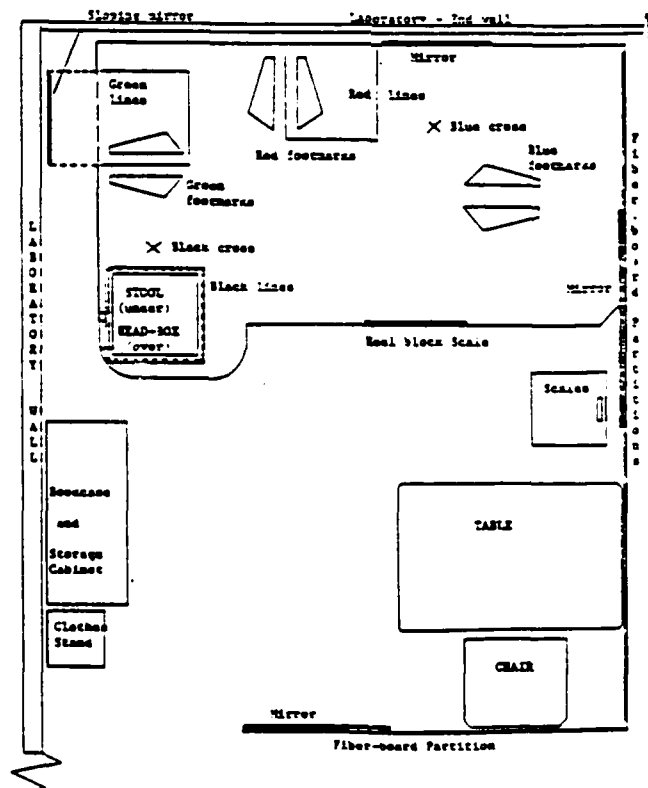


Figure 1. Plan diagram of the anthropometry rig.

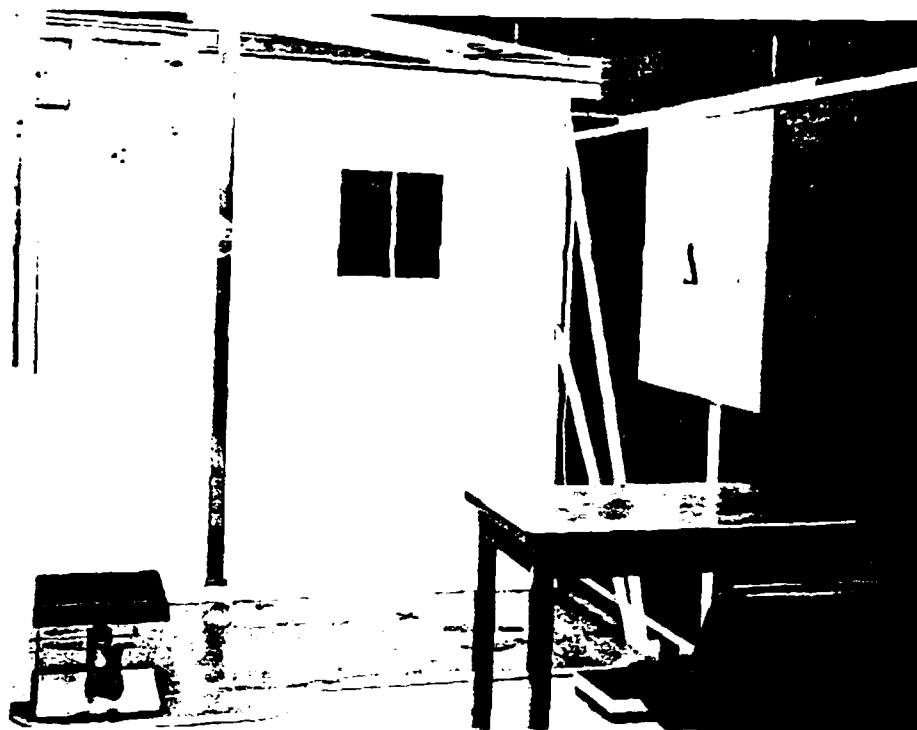


Figure 2. General view of measuring rig.

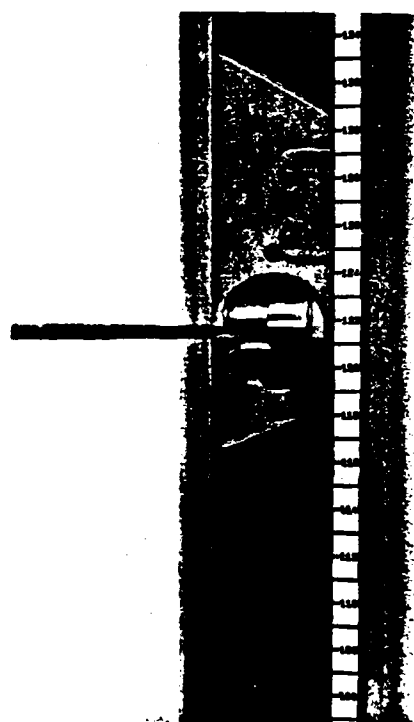


Figure 3. Illustration of datum probe and vertical scale.

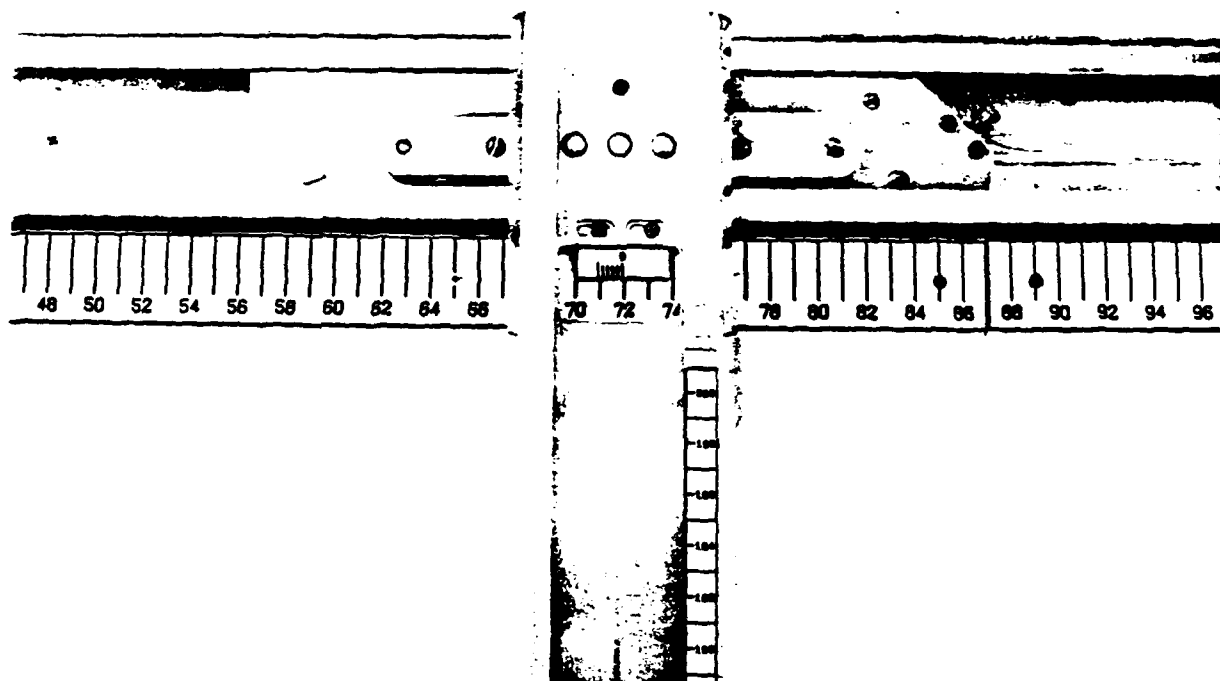


Figure 4. Illustration of horizontal scale.

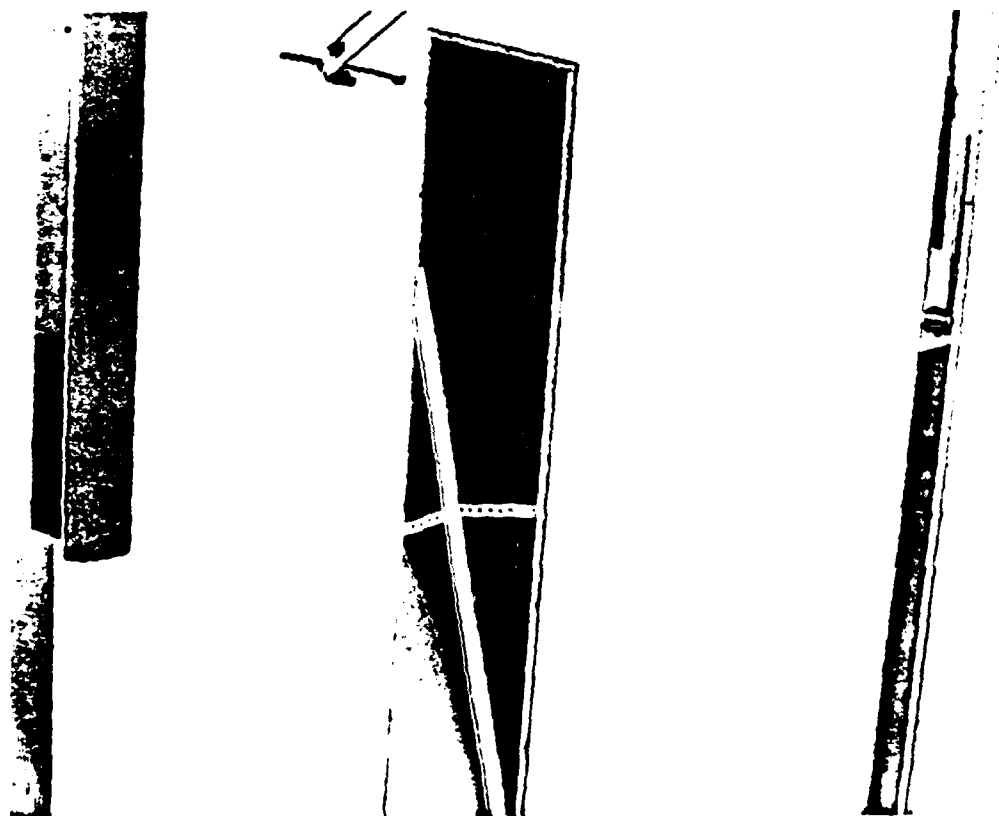


Figure 5. Illustration of sloping mirror.



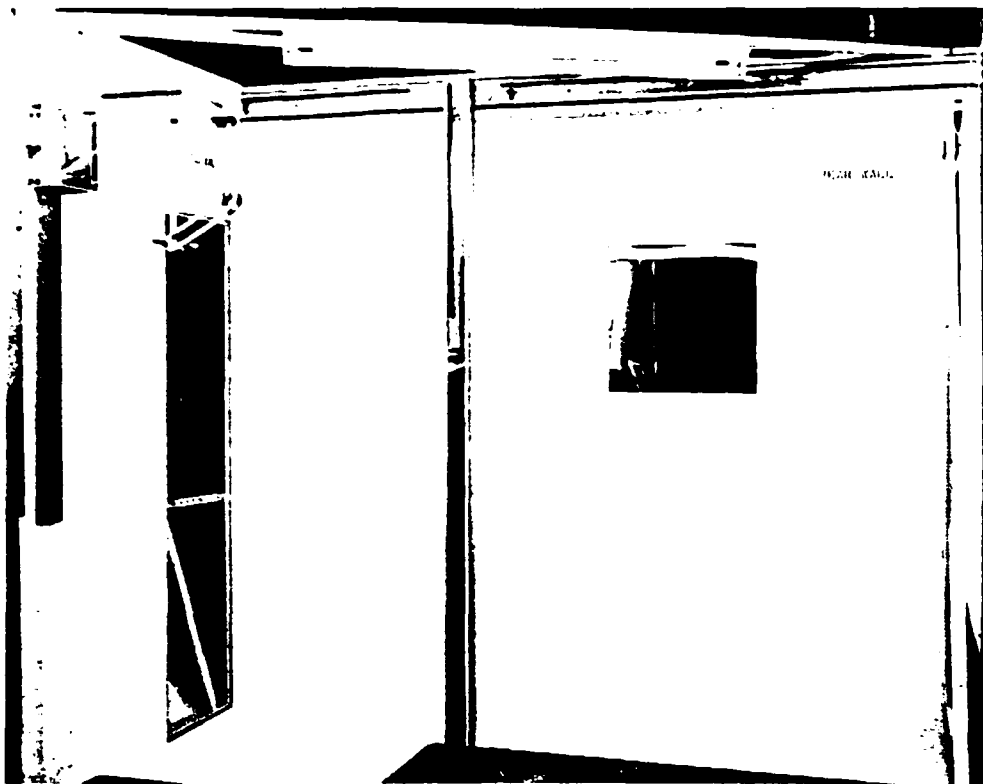


Figure 6. Full view of measuring rig.

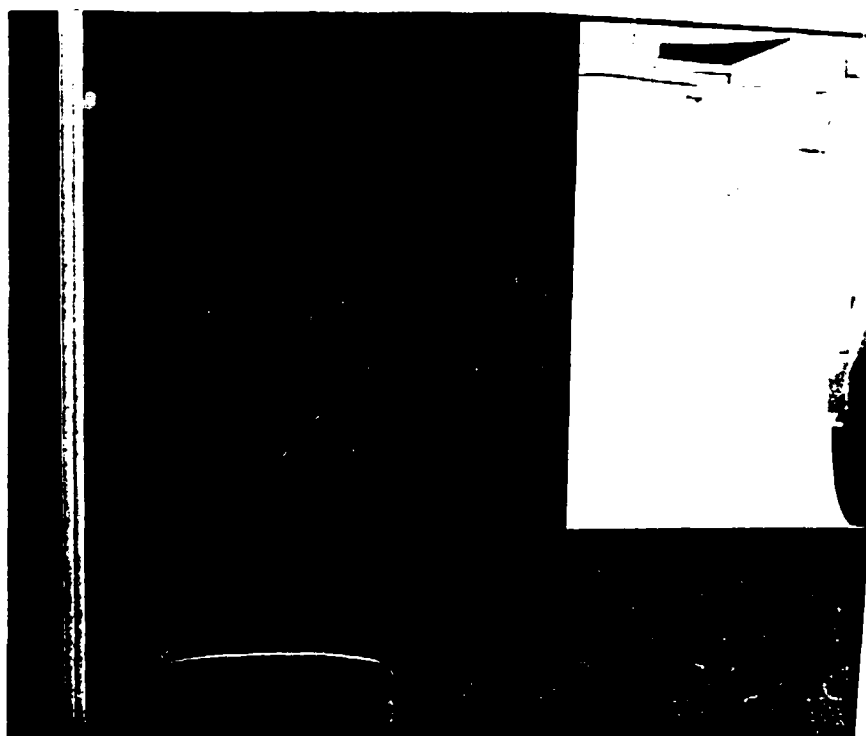


Figure 7. Illustration of fixed wall mirror.

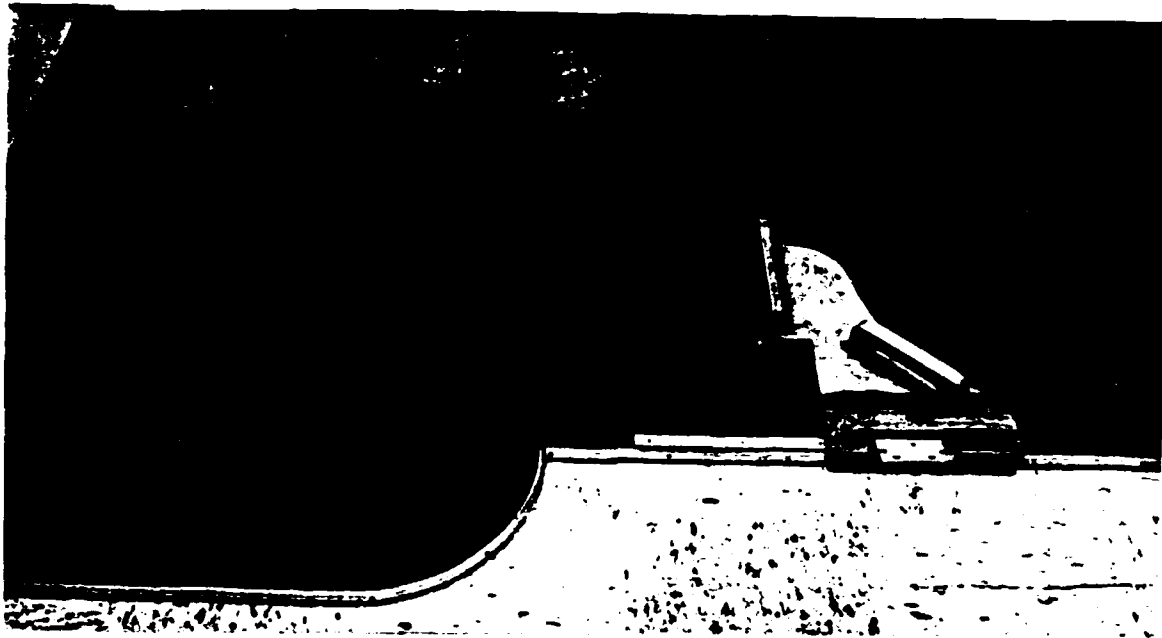


Figure 8. Illustration of floor markings.

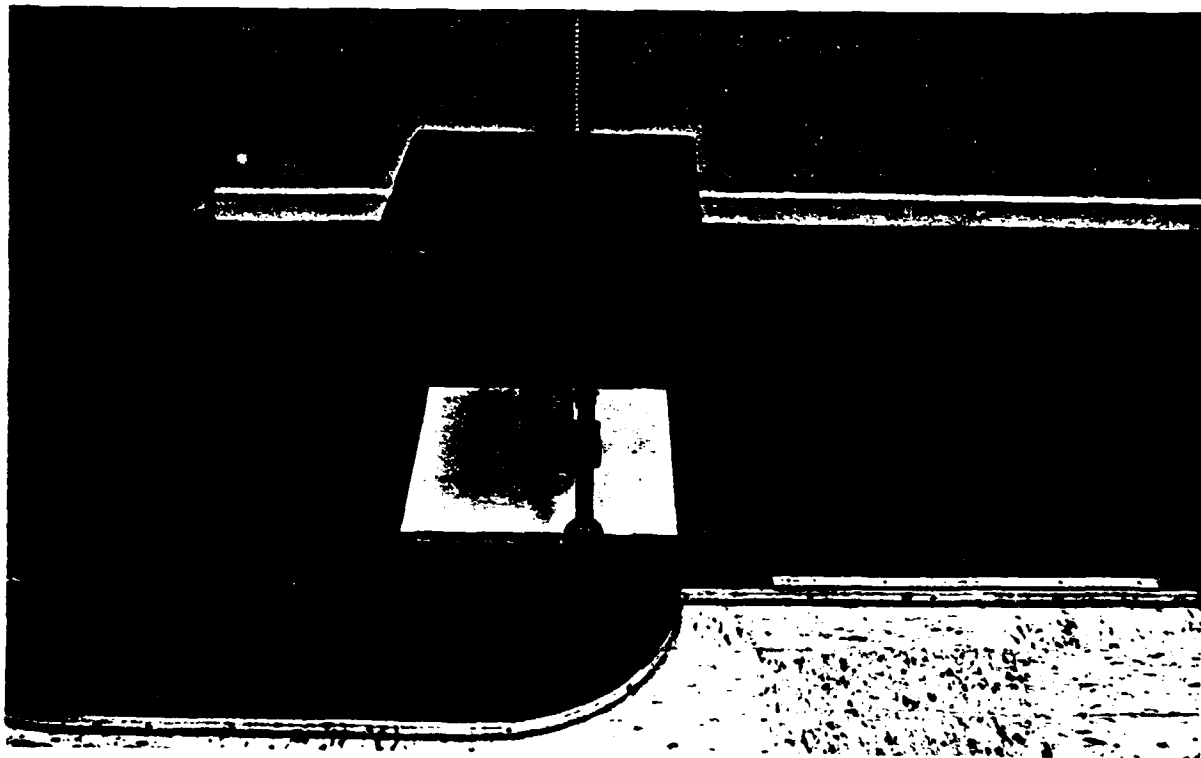


Figure 9. Illustration of stool.

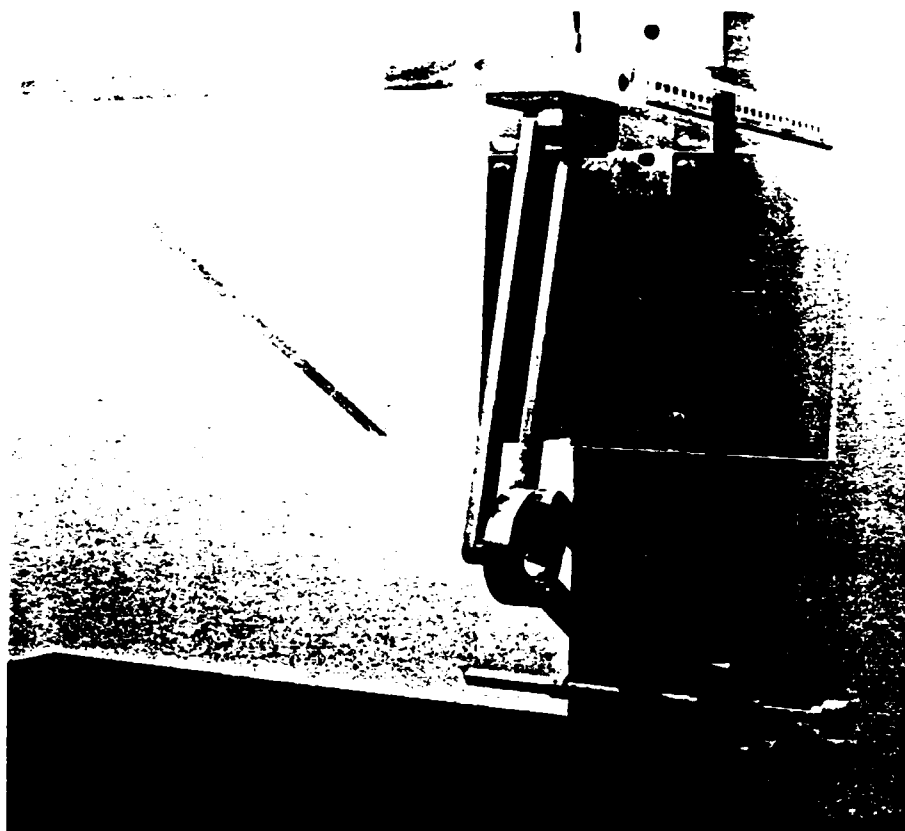


Figure 10. Head measuring rig.

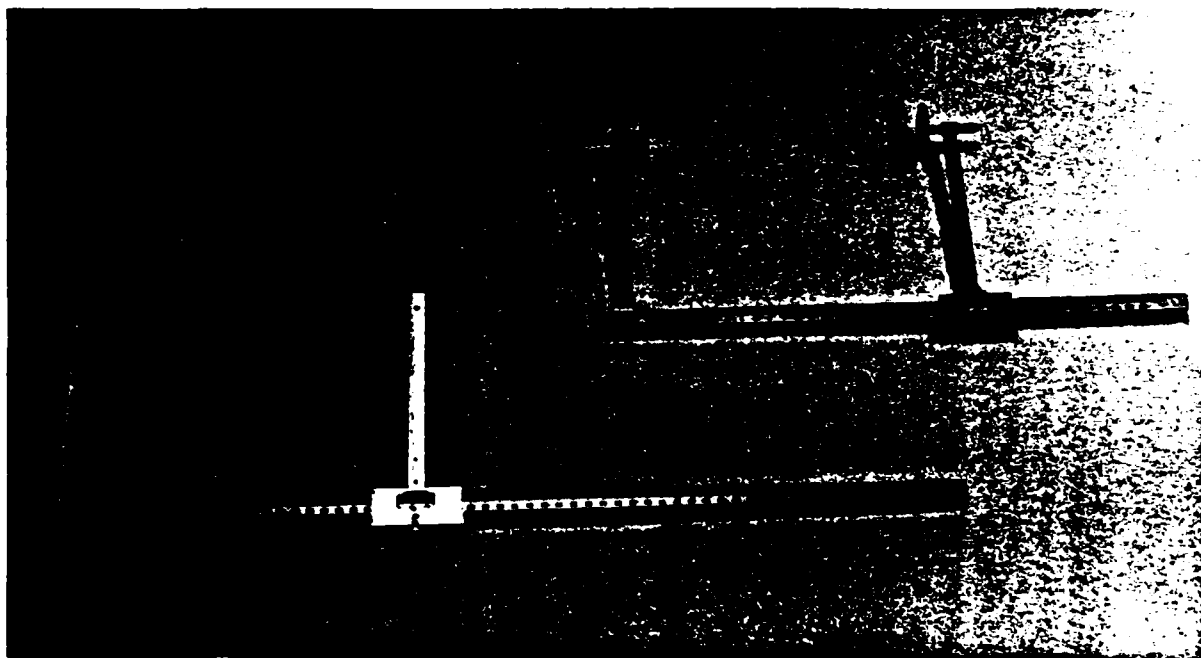


Figure 11. Head and body calipers.

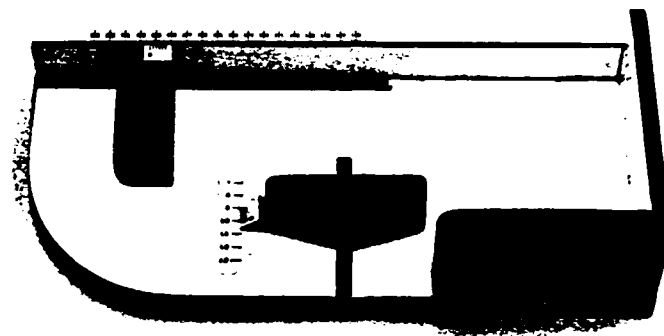


Figure 12. Foot measuring box.

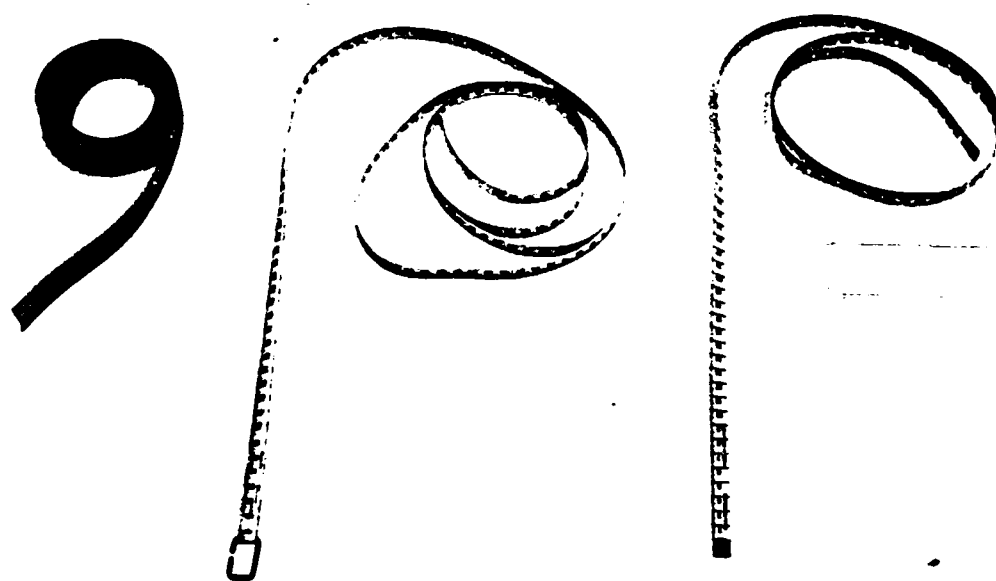


Figure 13. Measuring tapes, waist belt, and body marking template.

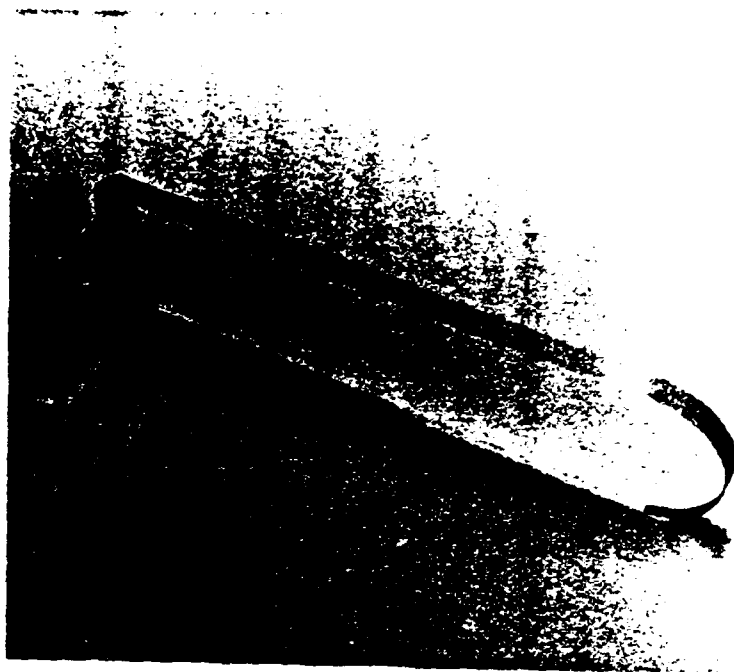


Figure 14. Knee block.

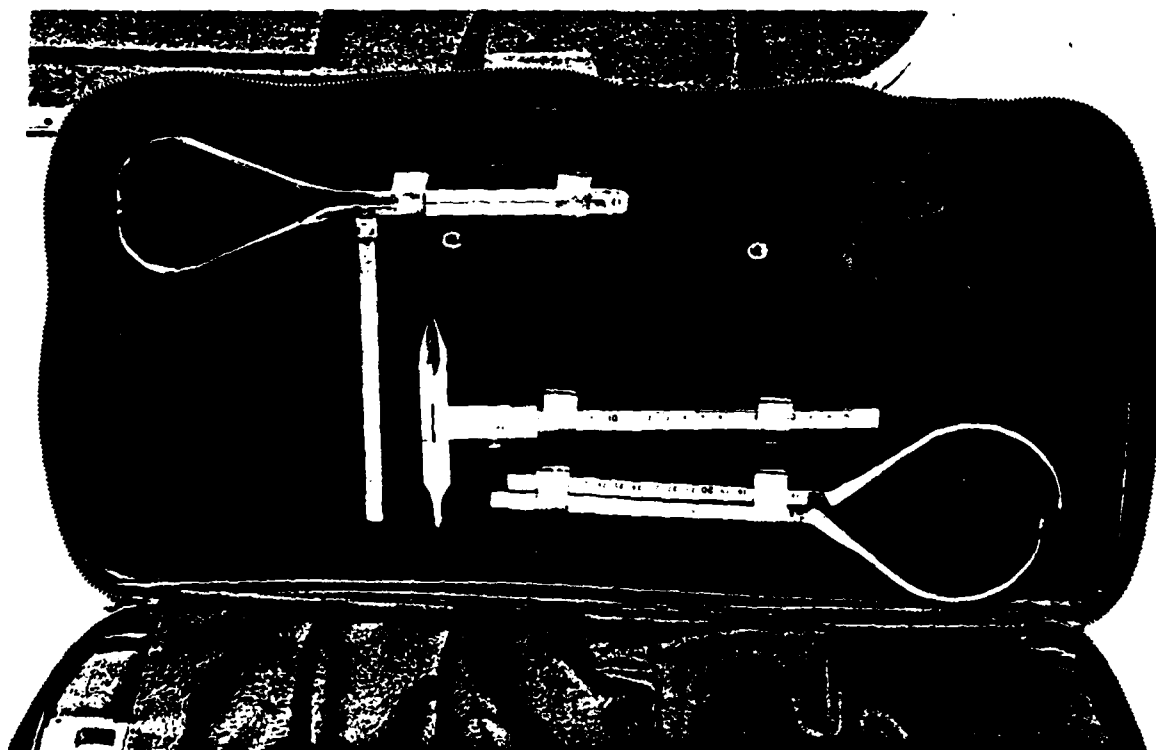


Figure 15. Standard anthropometer and ancillary equipment.

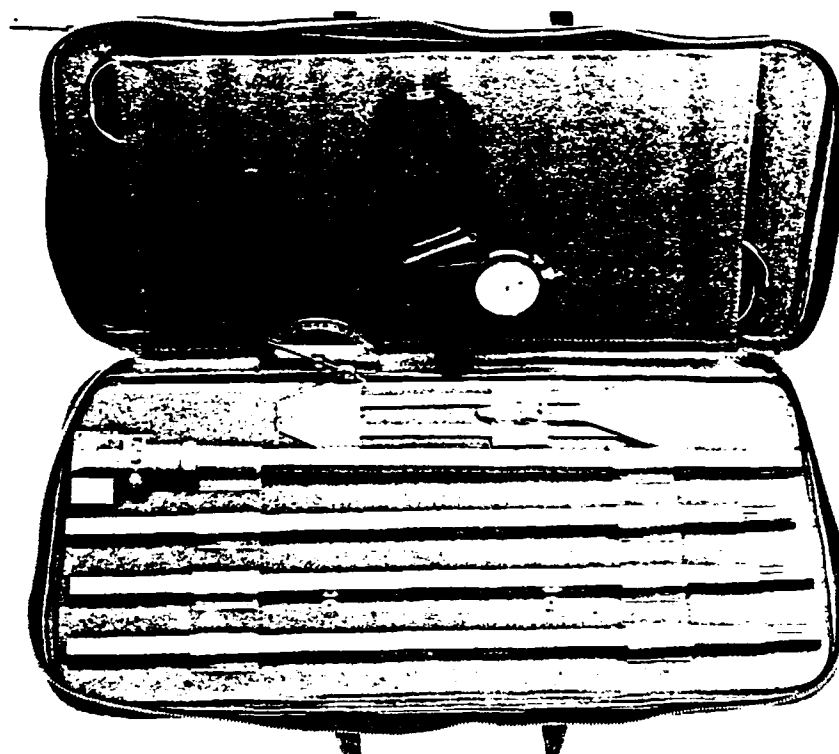


Figure 16. Anthropometer and ancillary equipment.

## SUMMARY OF TERMS AND DEFINITIONS

### Postures

- |                     |  |
|---------------------|--|
| Standing            | : Subject stands comfortably erect but NOT rigidly to attention. Weight equally distributed on both feet placed approximately 100 mm (4 in.) apart (Fig. 17).  |
| Sitting             | : Sitting comfortably erect on the stool with trunk straight. Stool height adjusted so that the line from the trochanter to the epicondyle is horizontal, feet flat on the floor and shins vertical (Fig. 18). |
| Sitting (Head Rig)  | : Sitting comfortably on the stool, head forward facing and with the top and back of the head in firm contact with the head box datum faces (Fig. 19).   |
| Head Forward Facing | : Head held comfortably erect, eyes looking directly into their reflection in the opposite vertical mirror (Fig. 19).  |

### Measurement Terms

- Datum Probe** : Measurements using the datum probe (unless stated otherwise) are taken with light pressure applied at the point of body contact. Care is taken NOT to indent the skin unduly.
- Tape** : Measurements using the tapes (unless stated otherwise) are taken with tape tension such that the skin is NOT significantly indented. Whenever possible, the calibrated edge of the tape is aligned with the line of the required measurement.
- Calipers** : Measurements using calipers (unless stated otherwise) are taken with light pressure applied at the point of body contact. Care is taken NOT to indent the skin significantly, but pressure is sufficient to flatten the hair where necessary.

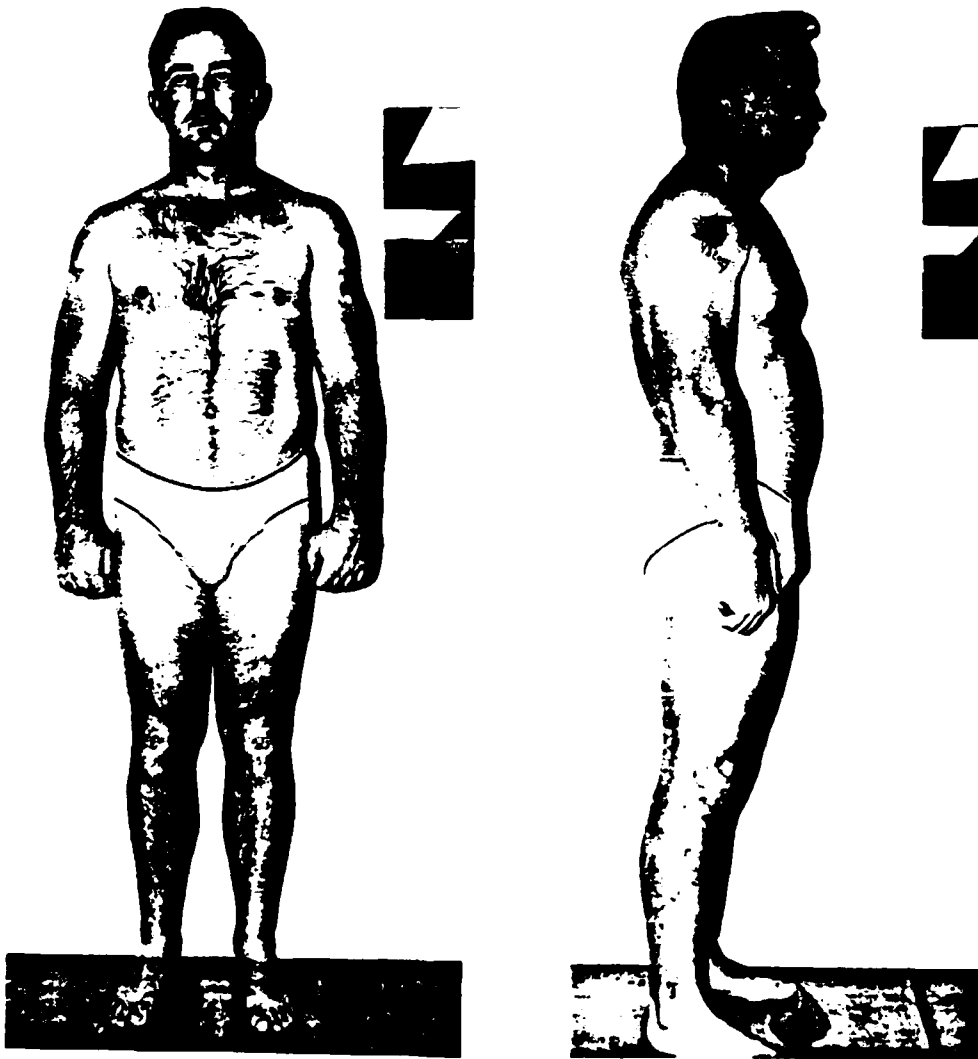


Figure 17. Illustration of standing posture.



Figure 18. Illustration of sitting posture.



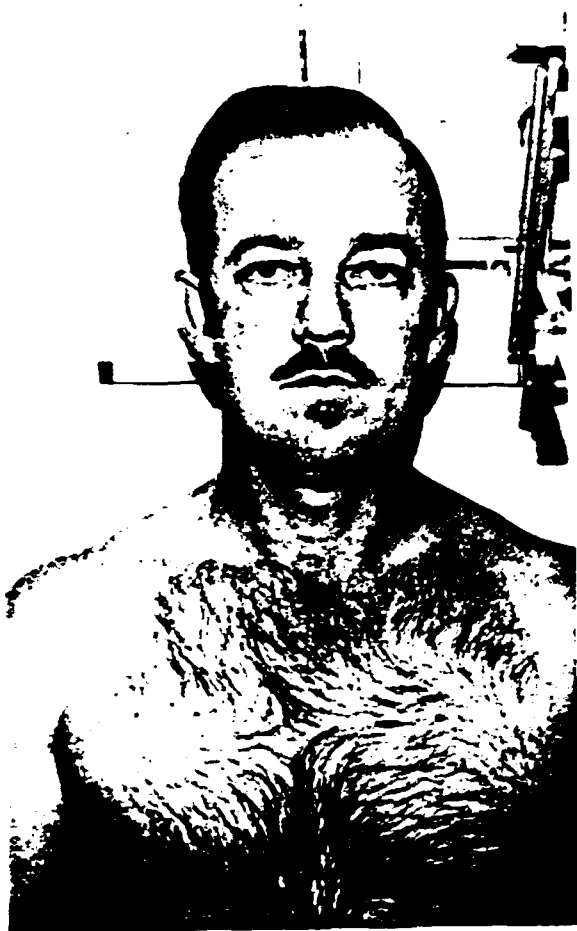


Figure 19. Illustration of head rig posture.

## Body Marks

Use a felt-tip pen, standing posture with the shoulders relaxed and the arms at the sides (Diagram, Fig. 20)

- Waist Mark** : A firmly fitting Velcro belt is placed around the trunk at the natural waist indent and parallel to the floor. Four horizontal marks are made on the skin adjacent to the lower edge of the belt. The marks are positioned across the front and back midlines, and at the sides of the waist (Fig. 21).
- Shoulder Marks** : The template is placed on the shoulders with its centerline overlying the centerline of the body. A mark is drawn on each shoulder down the inside edge of each arm (90 mm from the midline) as shown in Figure 22.
- Acromial Mark** : The lateral edge of the acromion process on the left shoulder is located, and a line is drawn horizontally 10 mm below it (Fig. 23).
- Cervicale Mark** : A horizontal mark is made over the spine of the seventh cervical vertebra. Where possible this is located by palpation with the head erect. Otherwise the head is bent forward enabling the bone to be located more easily, when the head is returned to the erect posture and the mark made (Fig. 24).
- Wrist Mark** : A mark is made on the skin over the distal end of the styloid process of the left radius (Fig. 25).
- Knee Mark** : Stool positioned at black lines. Adjust stool fully down. Sit comfortably erect on stool, back and buttocks firmly against the end wall, thighs parallel to the rear wall, shins vertical, and feet flat on the floor. Adjust the height of the stool so that the long axis of the thighs is horizontal with the floor (see Sitting Posture, page 12). NB. If necessary, use the stool block to raise the sitting platform further. The knee block is placed vertically on the left knee against the patella (but NOT necessarily in contact with the shin). The knee mark is made on the upper surface of the thigh at the end of the short arm of the block (75 mm from the front of the knee) as shown in Figure 26.

### NOTE

Once the appropriate stool height has been set for a subject, it is retained throughout the measuring session and must NOT be altered at all.

- |   |                              |
|---|------------------------------|
| A Shoulder Marks 90 mm each<br>side of mid-line | D Horizontal, Waistline Mark |
| B Cervicale Mark                                | E Wrist Mark                 |
| C Acromial Mark                                 | F Knee Mark                  |

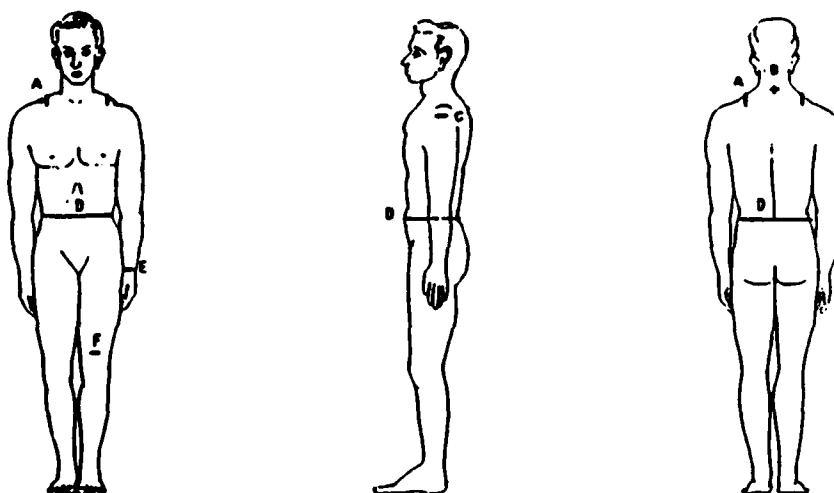


Figure 20. Diagram of body marks.

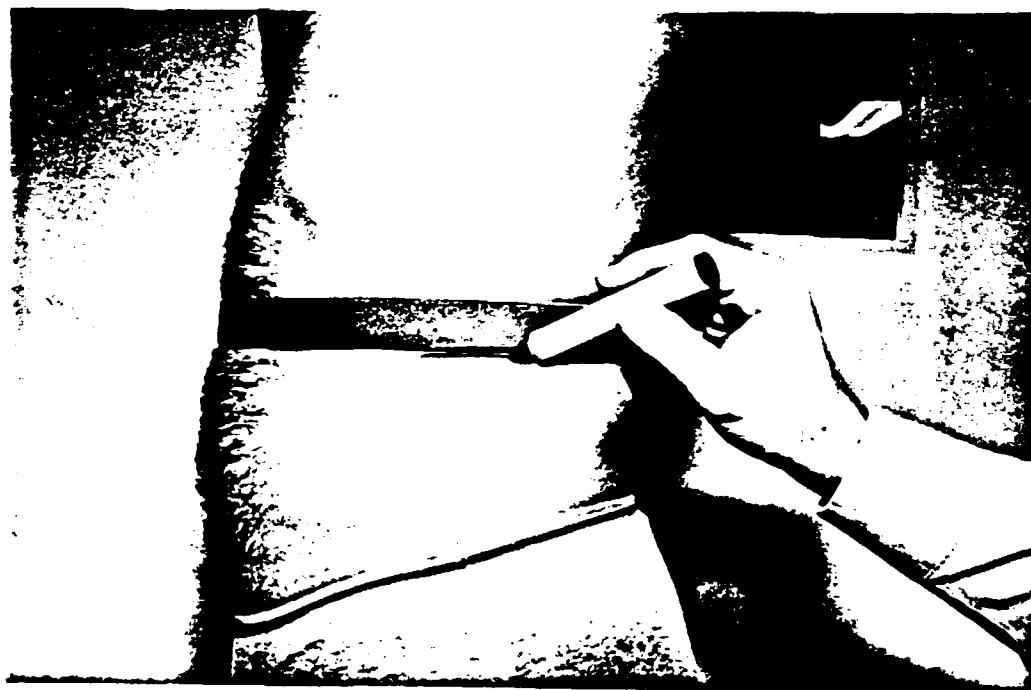


Figure 21. Illustration of waist mark

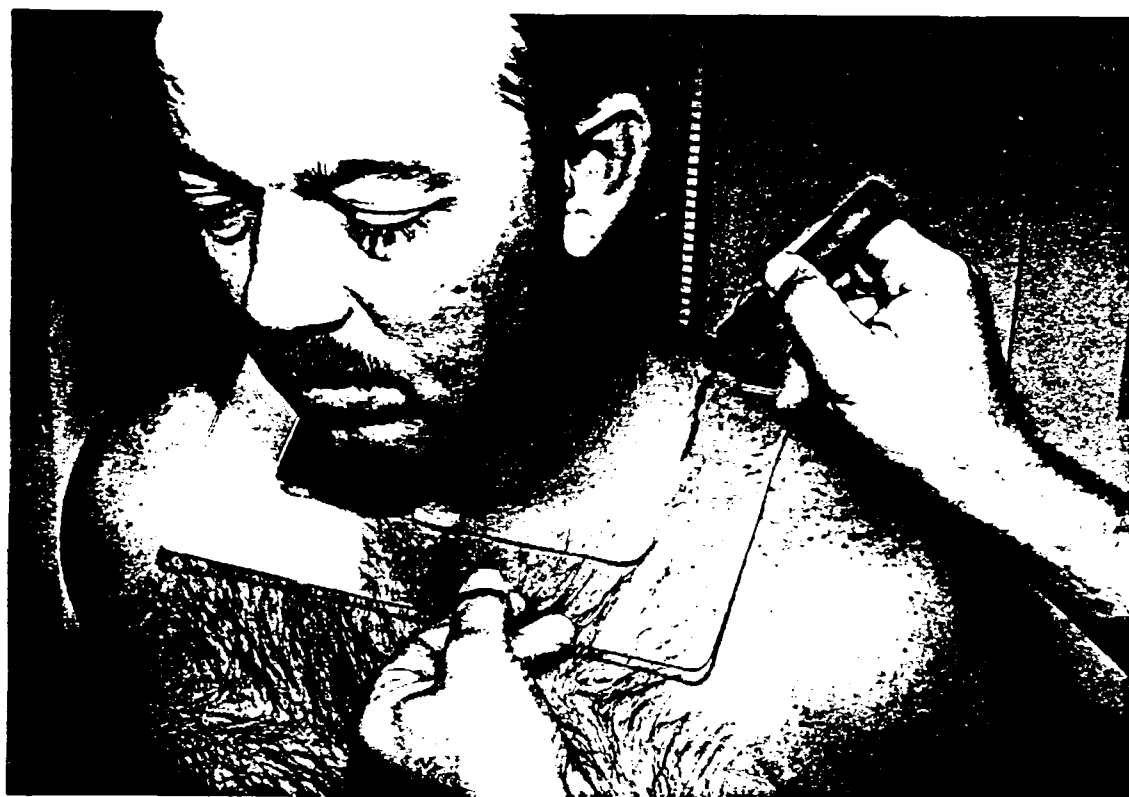


Figure 22. Illustration of shoulder mark.

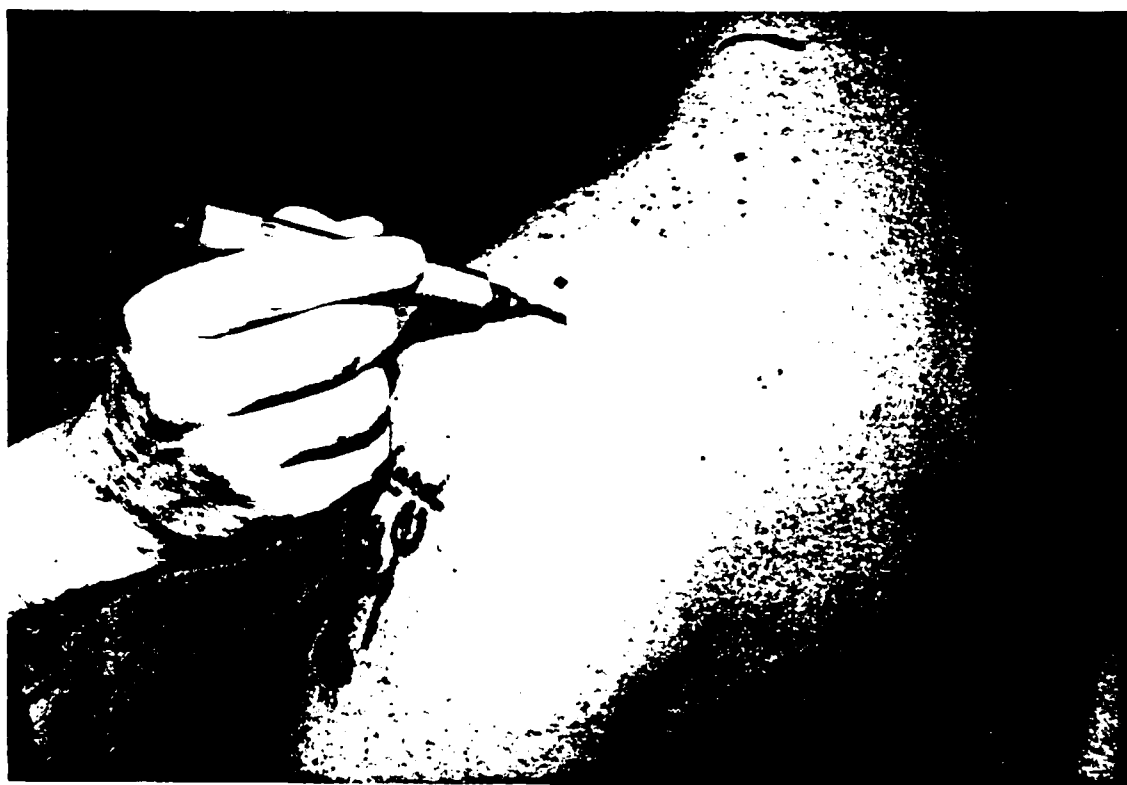


Figure 23. Illustration of acromial mark.

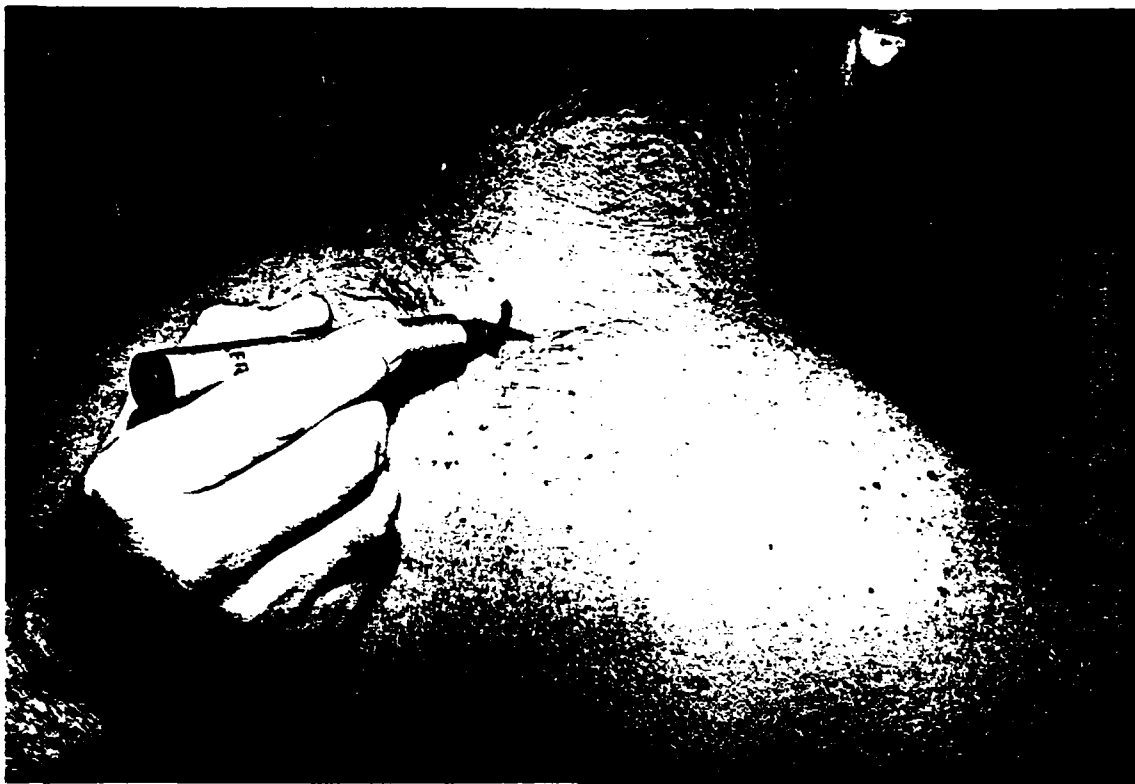


Figure 24. Illustration of cervicale mark.



Figure 25. Illustration of wrist mark.

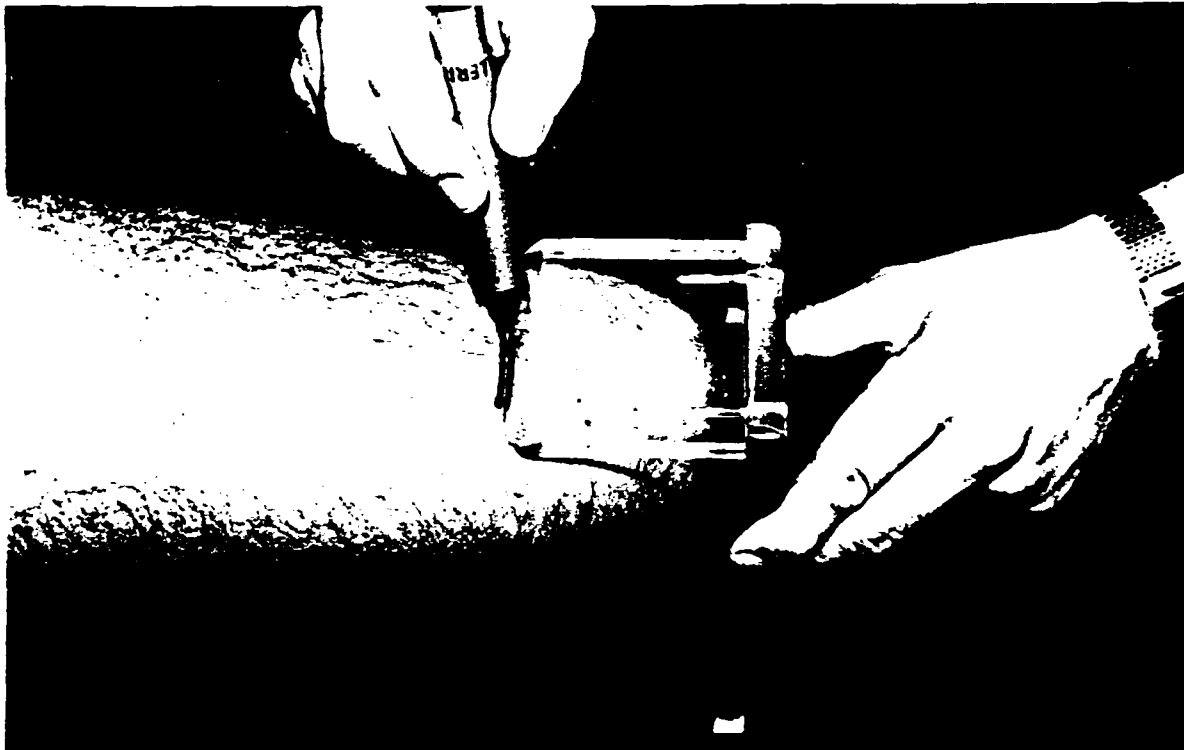


Figure 26. Illustration of knee mark.

#### Anatomical (Figs. 27-31) Terms

Abdomen	: Region of the lower trunk positioned below the rib cage and above the pelvis.
Acromion	: Tip of the outermost edge of the acromial process of the scapula (shoulder blade). Positioned on the upper aspect of the shoulder in the midcoronal plane at the junction of the lateral end of the clavicle (collar bone) and the scapula; also called the acromiale.
Ankle	: Joint formed by the lower ends of the tibia and fibula (shin bones), and the tarsal bones of the foot; lying between the shin and foot.
Anterior	: Pertaining to the front of the body.
Arm	: Upper limb of the body, comprising the shoulder, upper arm, forearm, wrist, and hand.
Back	: The posterior aspect of the trunk.
Brow Ridges	: Bony prominences lying just above the eye sockets; also called glabella.

Buttocks	: Fleshy protuberances on the posterior aspect of the body at the junction of the lower back and the upper part of the legs.
Calf	: Fleshy portion of the lower leg below the knee joint.
Cervical	: Pertaining to the neck.
Cervicale	: Tip of the spine of the 7th cervical vertebra situated at the base of the neck posteriorly.
Chest	: Region of the upper part of the trunk, bounded by the rib cage.
Coronal Plane	: A vertically orientated, side to side plane of the body.
Crotch	: Region at the lowermost end of the trunk situated between the upper thighs.
Deltoid	: Fleshy muscle which overlies the outer aspect of the shoulder and the upper arm.
Elbow	: Joint formed by the lower end of the humerus (upper arm bone) and the radius and ulna (forearm bones), lying between the upper arm and the forearm.
Face	: Anterior aspect of the head.
Finger	: Individual digit of the hand, anatomically numbered from 2 (forefinger) to 4 (little finger). Note: The thumb is Digit 1.
Fingertips	: The most digital tip of the longest finger (usually Digit 3 -middle finger) with the hand held straight, thumb in line with the fingers.
Foot	: Lowermost portion of the leg, lying below the ankle.
Forearm	: Lower portion of the upper limb, lying between the elbow and the wrist.
Forefinger	: First finger of the hand; also called the index finger.

#### NOTE

In anatomical terms the forefinger is digit 2.

Glabella	: The bony ridge of the eyebrows. See also brow ridges.
----------	---

Hand	: Lowermost portion of the arm, lying below the wrist; comprising the palm and fingers/thumb.
Head	: Region of the body above the neck; comprising the bony skull vault containing the brain. Also incorporates the special sense organs: eyes, ears, mouth and nose.
Heel	: Lowermost, posterior aspect of the foot.
Hip	: Joint formed by the upper end of the femur (thigh bone) and the pelvis; lying between the lower trunk and upper leg.
Knee	: Joint formed by the lower end of the femur (thigh bone) and the upper end of the tibia (shin bone). Separates the thigh from the calf.
Lateral	: Lying towards the sides of the body; opposed to medial.
Lips	: Fleshy parts of the face surrounding the mouth.
Medial	: Lying near the midsagittal plane of the body; opposed to lateral.
Menton	: Lower edge of the tip of the chin in the midline of the body.
Metacarpal	: The bones of the hand, lying between the bases of the fingers and the wrist.
Metatarsal	: The bones of the foot, lying between the bases of the toes and the ankle/instep.
Midsoulder	: The point on the upper surface of the shoulder at the shoulder mark on the midcoronal plane of the body.
Nasion	: Point of maximum depression in the midline of the body at the junction of the nose and forehead.
Neck	: Flexible portion of the body lying above the shoulders and supporting the head.
Nuchale	: Small bony prominence in the sagittal plane of the skull, and situated at the back of the head where head and neck meet.
Occiput	: Bony prominence at the back of the head.
Ocular	: Pertaining to the eyes.
Olecronon	: The proximal bony prominence of the ulna, forming the posterior aspect of the elbow.



Posterior	: Pertaining to the back of the body.
Pupil	: The dark, central portion of the eye.
Radius	: One of the two bones of the lower arm; it extends from the lateral side of the elbow to the wrist at the base of the thumb.
Sagittal	: A vertically orientated, front to back plane of the body.
Sellion	: Bridge of the nose; see also nasion.
Shoulder	: Fleishy portion of the upper trunk overlying the shoulder joint which is formed by the upper end of the humerus (upper arm bone) and the shoulder blade.
Subnasale	: Point in the midline of the body at the junction of the upper lip and the underside of the nose.
Thigh	: Fleishy portion of the upper leg, lying below the hip and above the knee.
Tragion	: Notch in the cartilage of the ear just above and immediately in front of the ear hole.
Trunk	: The large central portion of the body comprising the chest and abdomen.
Ulna	: One of the two bones of the lower arm; it extends from the point of the elbow (olecranon) to the wrist.
Upper arm	: The part of the upper limb lying below the shoulder and above the elbow.
Vertebra	: Bone of the spinal column, or backbone.
Vertex	: The top of the head in the midsagittal and mid-coronal planes, when the head is held in the level, forward facing posture.
Waist	: The natural indentation of the body in the horizontal plane at midtrunk level.
Wrist	: Joint formed by the lower ends of the radius and ulna, and the bones of the carpus. Separates the forearm and the hand.
Zygoma	: Bony prominences of the skull forming the sides of the face; also called cheek bones.

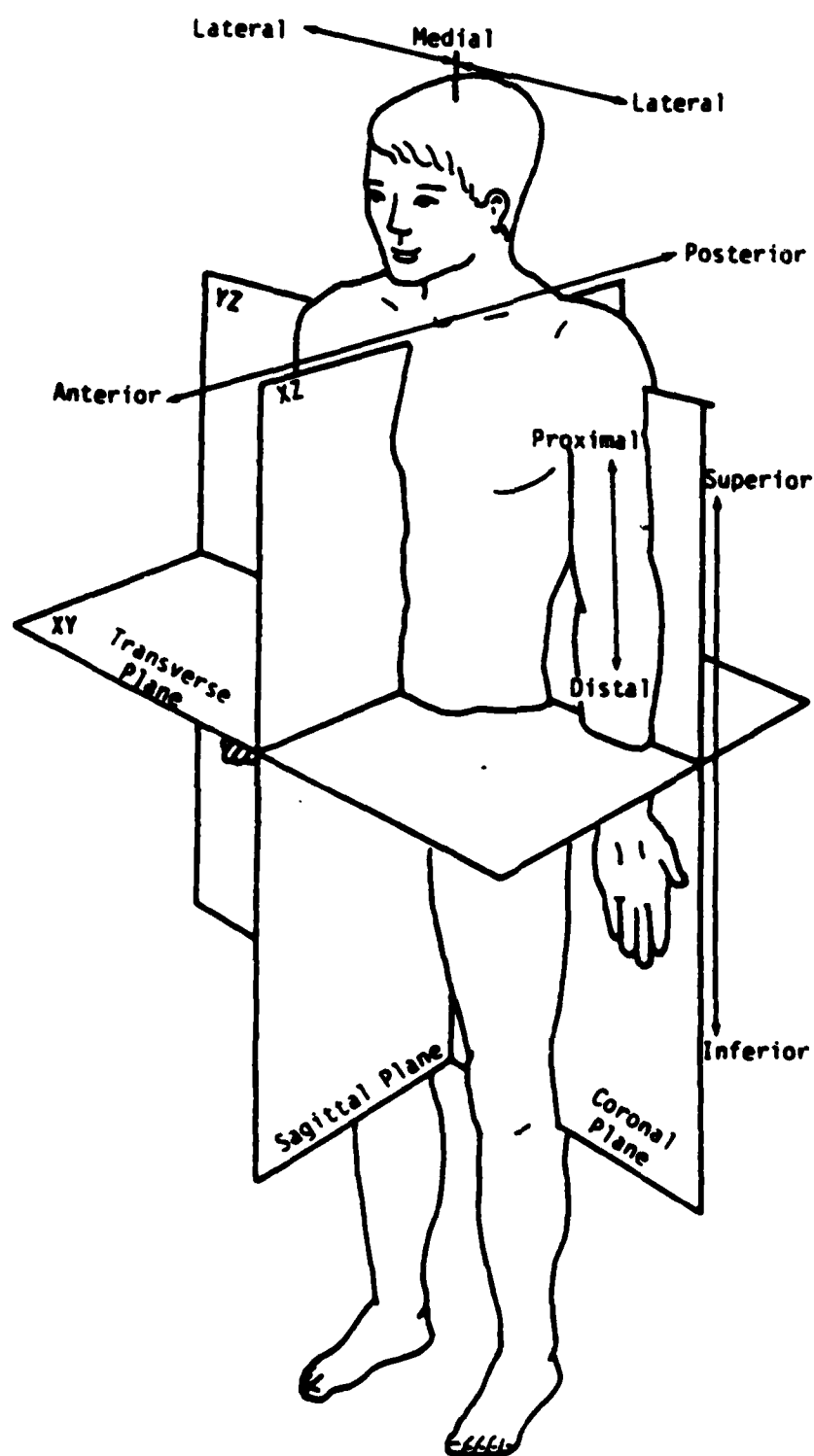


Figure 27. Anatomical planes and orientations.

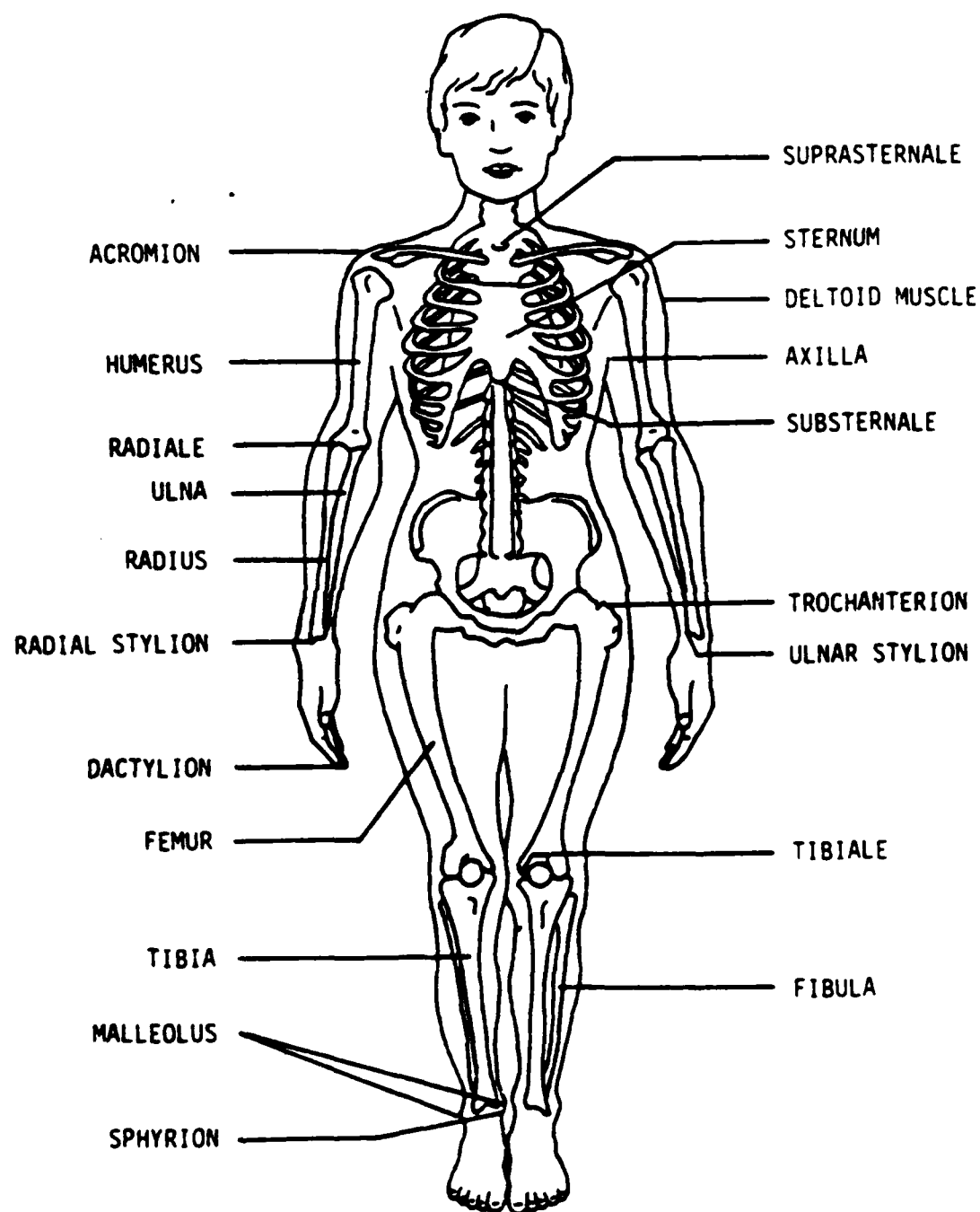


Figure 28. Anatomical and anthropometric landmarks (front view).

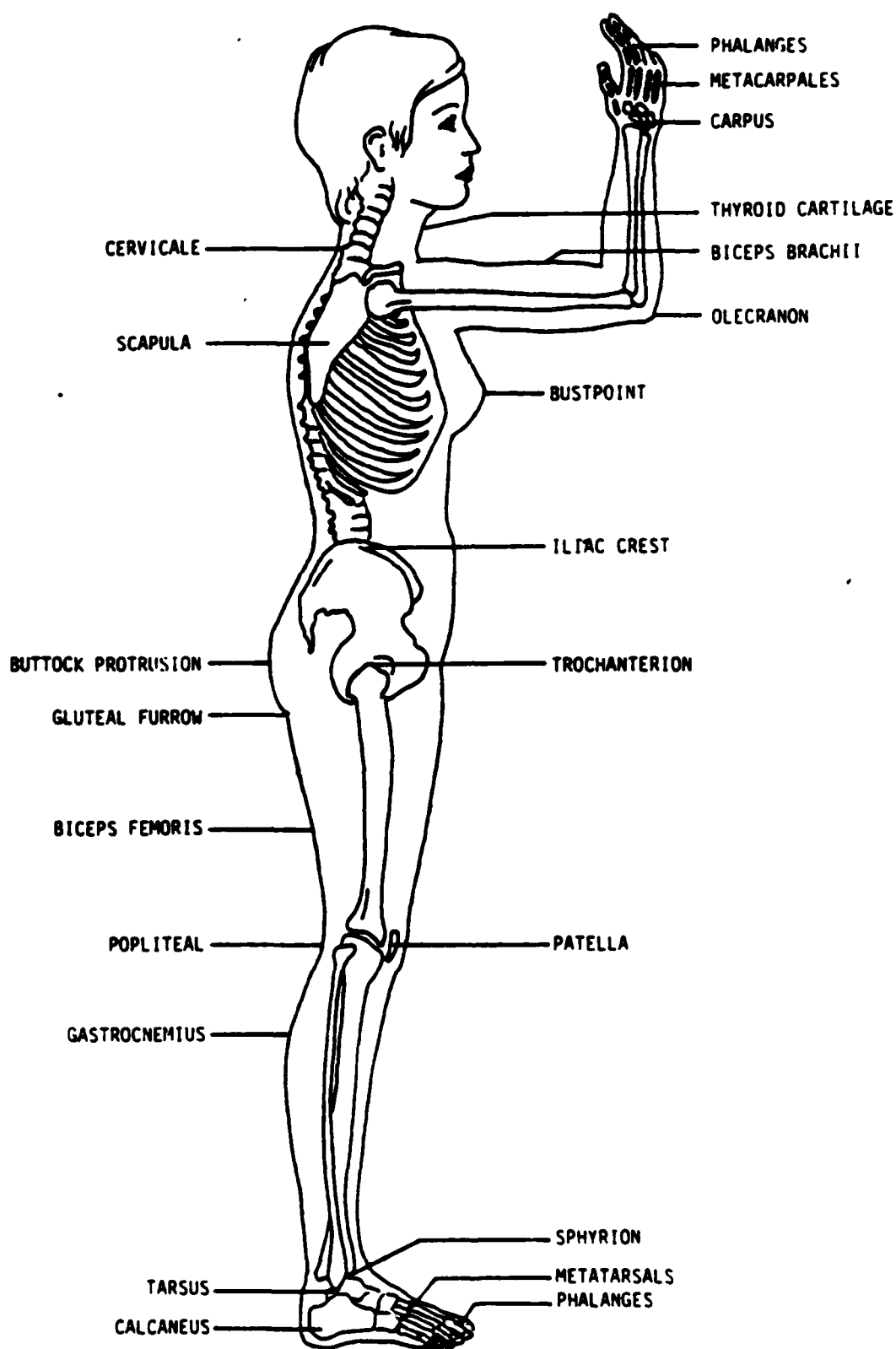


Figure 29. Anatomical and anthropometric landmarks (side view).

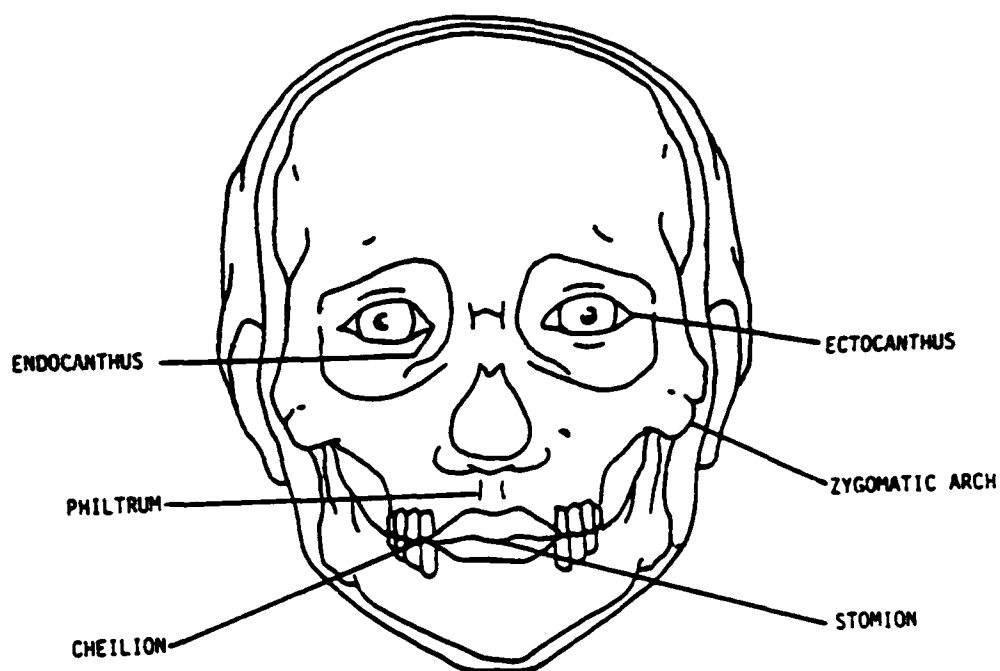


Figure 30. Anthropometric landmarks of the head and face (front view).

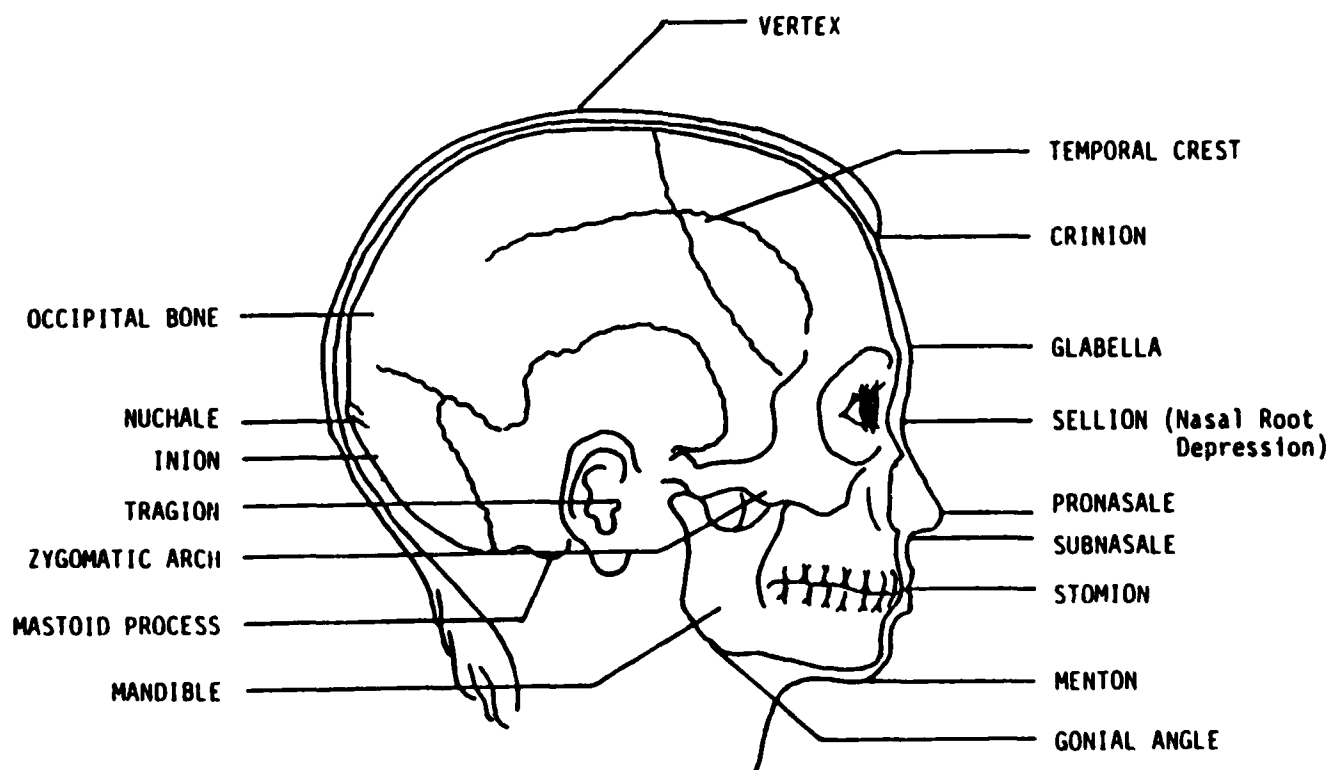


Figure 31. Anthropometric landmarks of the head and face (side view).

## DEFINITION OF MEASUREMENTS

### Subject Information

The following information will be obtained from candidates processed through the Anthropometry laboratory, and will be stored as an integral part of the Programmed Assessment of Aircrew Clothing and Equipment (PAACE) Anthropometry Data Base. A record sheet is illustrated in Figure 32.

- a. Name/Rank
- b. Integration laboratory subject's security ident code.
- c. Organization/Office symbol/Telephone No.
- d. Date of Birth
- e. Date measured/measurer ident code.
- f. Rating (if aircrew).
- g. Total flying hours experience (if applicable).
- h. Current aircraft type (if applicable).
- i. F/R cockpit as applicable.

### Body Measurements

This section of the Handbook lists a detailed description of how each body measurement should be carried out; in the format of a separate page for each measurement under the following five major headings:

- a. Standing measurements. (Fig. 33).
- b. Sitting measurements. (Fig. 34).
- c. Head/Neck measurements. (Fig. 35).
- d. Hands/Feet measurements. (Fig. 36).
- e. Derived measurements.

A photographic illustration (Figs. 37-95) of the appropriate measurement appears below the descriptive text applicable to each measurement.

The definition of measures used in this Handbook resulted from careful cross-reference between methodologies used during the USAF 1967 survey (3), the RAF 1970/71 survey (4), the NASA Reference Publication (2), and the DOD Military Handbook of Anthropometry (5). A composite measurement definition was thus produced. However, since the anthropometry rig is based on the RAF design (4), the measurements have been aimed primarily at being conducted using this type of body measuring rig. It is emphasized that the measurement definitions detailed in this Handbook meet, in principle, the requirements of the document at Reference 5.

### NOTE

The number in parenthesis after the name of a measure refers to the NASA anthropometric classification number.

SUBJECT ANTHRO RECORD		Rank:	Name:	Org./Off-Symbol:	Tel:	D.O.B:	Ident:		
Date Measured:		Measurer:	Rating:	A/c Type:	Flying Exp. (Hrs):		Cockpit (F/R):		
No.	Measurement	Ref. No.	Value	Side	No.	Measurement	Ref. No.	Value	Side
1.	<u>STANDING</u> Height	957			33.	<u>HEAD/NECK</u> Tragion - Vertex	882		
2.	Elbow - Fingertip Length	319			34.	Tragion - Wall	884		
3.	Elbow - Wrist Length	324			35.	Glabella - Vertex	389		
4.	Stature	805			36.	Glabella - Wall (Head Length)	391		
5.	Waist Height	949			37.	Pupil - Vertex	289		
6.	Crotch Height	249			38.	Sellion - Vertex	739		
7.	Vertical Trunk Circ.	<div>L</div> 916			39.	Sellion - Wall	741		
8.	Chest Circ.	230			40.	Menton - Vertex	595		
9.	Elbow Fully Bent Circ.	301			41.	Menton - Wall	597		
10.	Waist Circ.	931			42.	Maximum Head Diagonal	437		
11.	Buttock Circ.	178			43.	Head Breadth	427		
12.	Thigh Circ.	852			44.	Bi.Tragion Breadth	142		
13.	Knee Fully Bent Circ.	516			45.	Bi.Ocular Breadth	138		
14.	Lower Thigh Circ.	561			46.	Bi.Zygomatic Bdth (Face Bdth)	165		
15.	Calf Circ.	207			47.	Lip Length	547		
16.	Ankle Circ.	058			48.	Menton - Sub.Nasale Length	592		
17.	<u>SITTING</u> Buttock - Heel Length	191			49.	Head Circ.	430		
18.	Cervicale Height	220			50.	Bi.Tragion Coronal Arc	144		
19.	Sitting Height	758			51.	Posterior Neck Length	686		
20.	Mid.Shoulder Height	612			52.	Neck Circ.	639		
21.	Acromial Height	025			53.	<u>HANDS/FEET</u> Hand Breadth	411		
22.	Elbow Rest Height	312			54.	Forefinger Length	345		
23.	Bi.Deltoid Breadth	122			55.	Finger Length, Digit III	346		
24.	Vertical Functional Reach	314			56.	Wrist Circ.	967		
25.	Functional Reach	867			57.	Hand Circ.	416		
26.	Chest Depth	236			58.	Foot Length	362		
27.	Abdo.Ext. - Wall (Stomach Depth)	021			59.	Foot Breadth	356		
28.	Thigh Clearance Height	856			60.	Ball of Foot Circ.	097		
29.	Knee Height	529			61.	<u>DERIVED MEAS.</u> Eye Height, Sitting	330		
30.	Buttock - Knee Length	194			62.	Neck Lgth. (Cervicale-Tragion)	222		
31.	Stool Height	816			63.	Upper Arm Lgth. (Acrom.-Elbow)	751		
32.	Hip Breadth	489			64.	Hand Length	420		
					65.	Menton - Sellion Length (Face Length)	586		

Figure 32. Anthro data record form.

A Neck Circumference	#52	J Ankle Circumference	#16
B Vertical Trunk Circ.	#7	K Crotch Height	#6
C Chest Circumference	#8	L Waist Height	#5
D Waist Circumference	#10	M Stature	#4
E Buttock Circ.	#11	N Lower Thigh Circumference	#14
F Wrist Circumference	#56	P Neck Length (Derived)	#62
G Thigh Circumference	#12	Q Posterior Neck Length	#51
H Calf Circumference	#15		

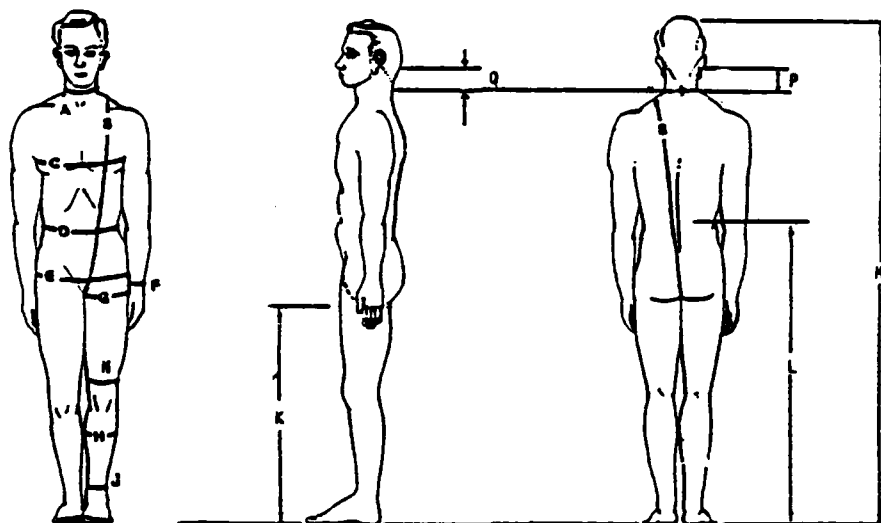


Figure 33. Diagram of body measures - standing.

A Bi-Deltoid Breadth	#23	G Highboulder Height, Sitting	#20	N Cervicale Height, Sitting	#18
B Chest Depth	#26	H Sitting Eye Height	#61	P Elbow Rest Height, Sitting	#22
C Hip Breadth, Sitting	#32	J Sitting Height	#19	R Abdominal Extension - Wall (Stomach Depth)	#27
D Stool Height	#31	K Vertical Functional Reach	#24	S Buttock - Knee Length	#30
E Thigh Clearance Height	#28	L Knee Height, Sitting	#29	T Buttock - Heel Length	#17
F Acromial Height, Sitting	#21	M Functional Reach	#25	V Upper Arm Length	#63

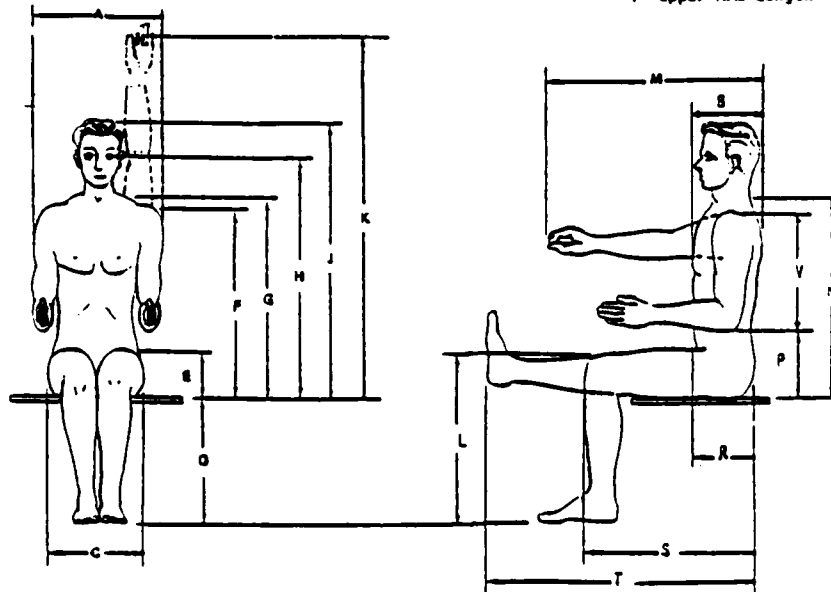


Figure 34. Diagram of body measures - sitting.



A Head Breadth	/43	H Glabella - Hair	/36	P Seillon - Hair	/39
B Bi-Tragion Coronal Arc	/50	(Head Length)		R Bi-Ocular Breadth	/45
C Head Circumference	/49	J Tragion - Hair	/34	S Bi-Zygomatic Breadth	/46
D Bi-Tragion Breadth	/44	K Menton - Hair	/41	(Face Breadth)	
E Menton - Vertex	/40	L Maximum Head Diagonal	/42	T Lip Length	/47
F Tragion - Vertex	/33	M Seillon - Vertex	/38	V Menton - Subnasale Length	/48
G Pupil - Vertex	/37	N Glabella - Vertex	/35	W Menton - Seillon Length	/65
				(Face Length)	

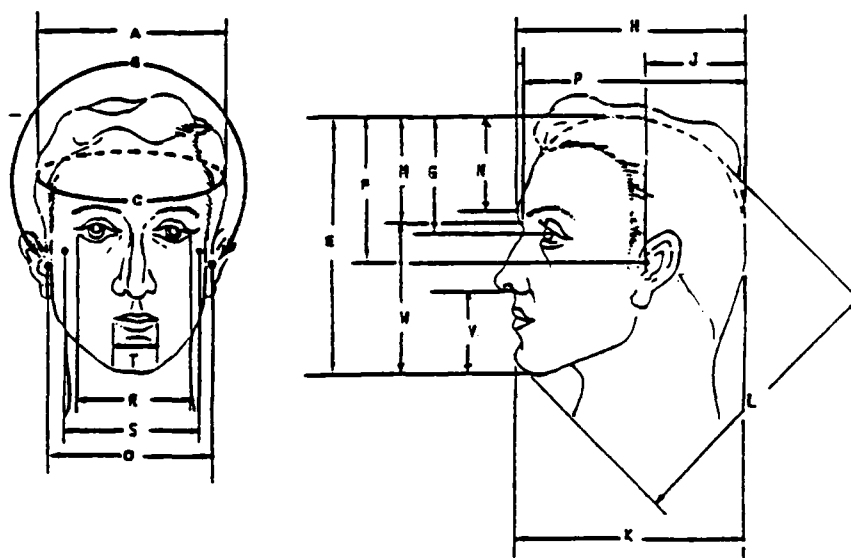


Figure 35. Diagram of body measures - head/neck.

A Elbow - Fingertip Length	/ 2
B Elbow - Wrist Length	/ 3
C Hand Length	/64
D Elbow Fully Bent Circumference	/ 9
E Knee Fully Bent Circumference	/13
F Foot Breadth	/59
G Ball of Foot Circumference	/60
H Foot Length	/58
J Hand Breadth	/53
K Forefinger Length	/54
L Finger Length, Digit III	/55
M Hand Circumference	/57

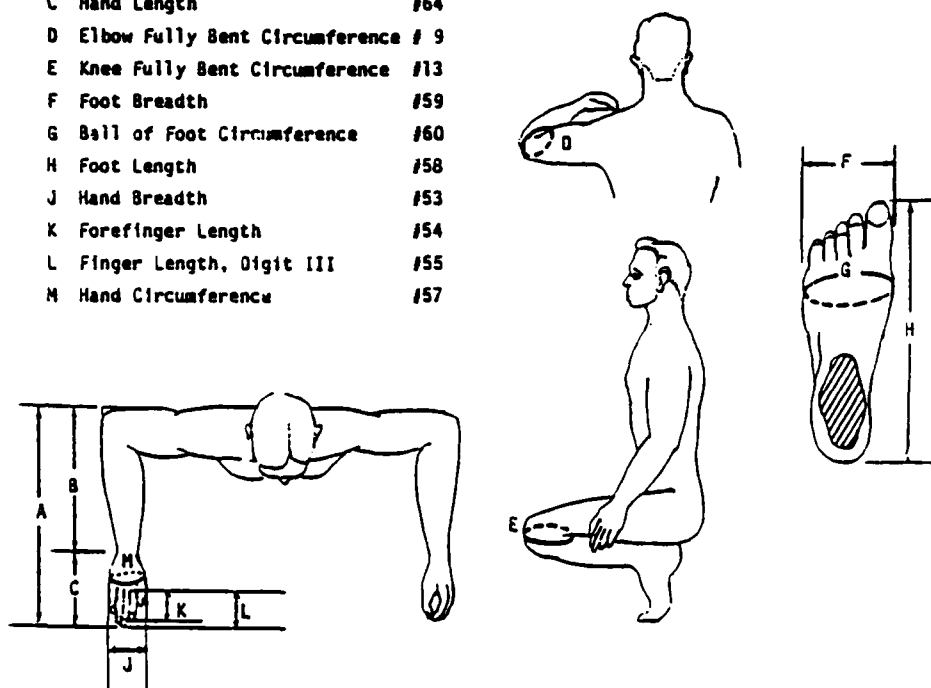


Figure 36. Diagram of body measures - hands/feet.

BODY MEASUREMENTS - STANDING

No. 1. WEIGHT (957)

Scales

Stand comfortably erect on the electronic scales, feet slightly apart.  
Record subject's weight to the nearest 0.5 kg (not illustrated).

No. 2. ELBOW - FINGERTIP LENGTH

(319)

Rig. Green foot marks.

Stand comfortably erect, back to end wall. Left upper arm horizontal with elbow touching the end wall. Left forearm horizontal and parallel to the rear wall with hand and fingers outstretched, palm down, in line with forearm. Measurements from end wall to datum probe at tip of longest finger of left hand.

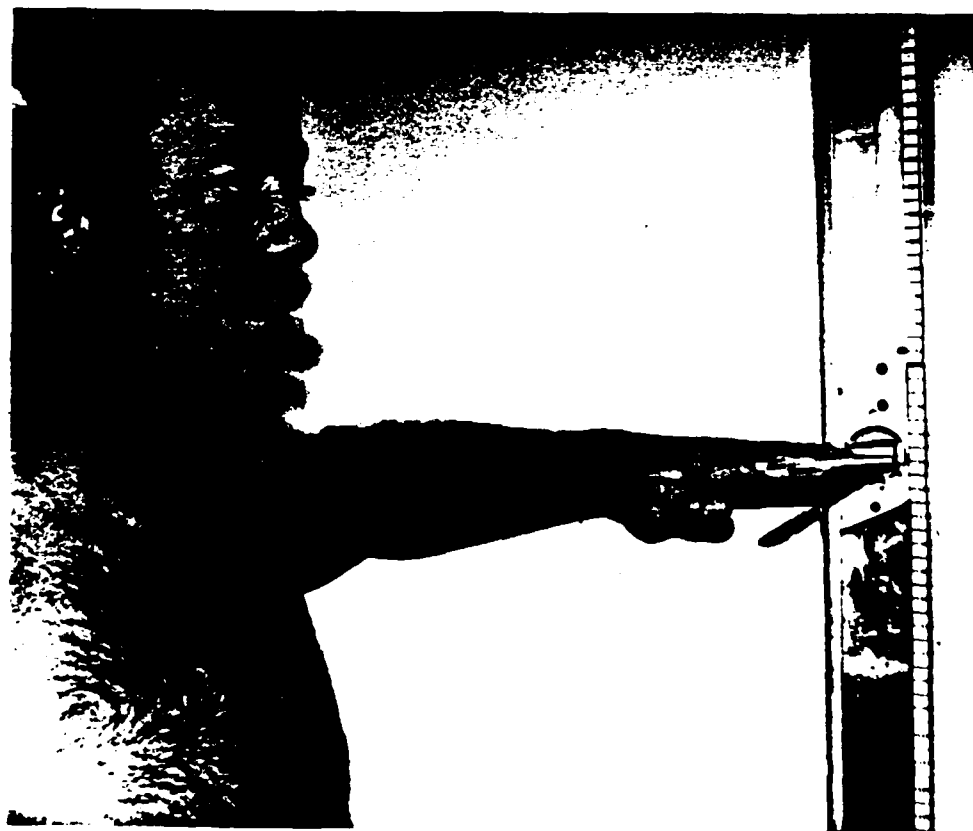


Figure 37. Elbow - fingertip length.

No. 3. ELBOW - WRIST LENGTH

(324)

Rig. Green foot marks.

Stand comfortably erect, back to end wall. Left upper arm horizontal with elbow touching the end wall. Left forearm horizontal and parallel to the rear wall with hand and fingers outstretched (thumb in line with fingers), back of hand facing rear wall with wrist mark uppermost. Measurement from end wall to datum probe at wrist mark.

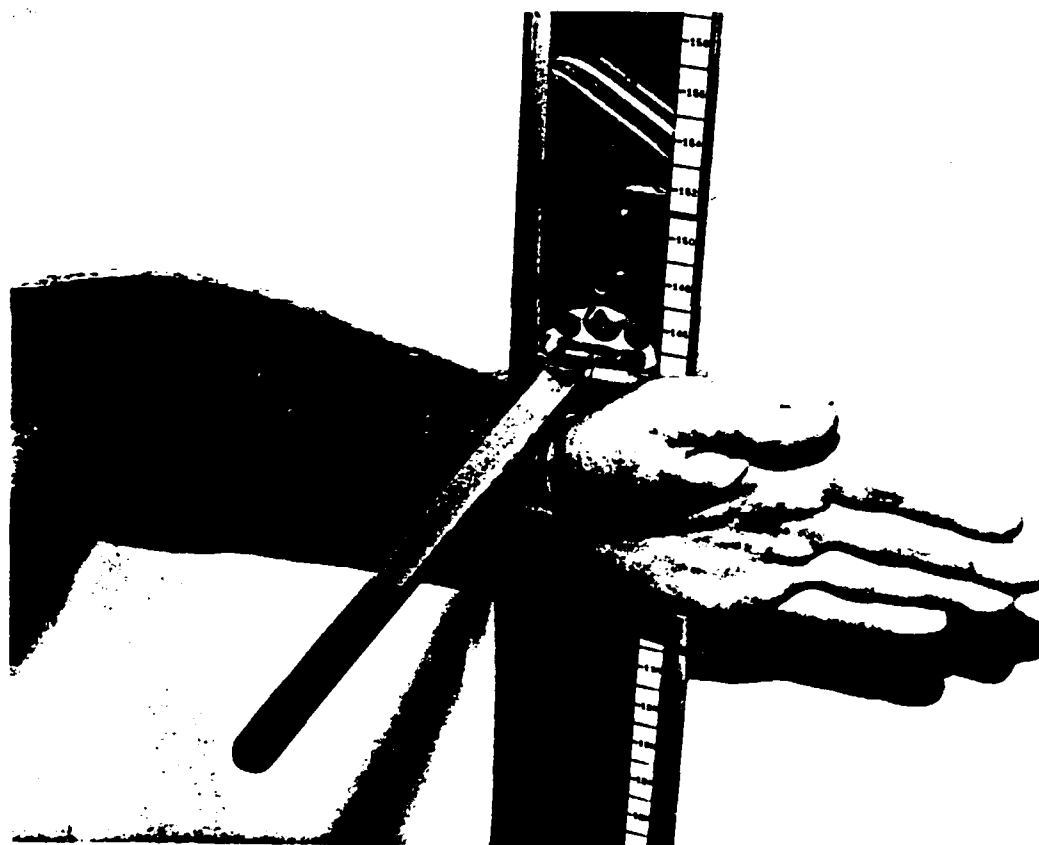


Figure 38. Elbow - wrist length.

No. 4. STATURE

(805)

Rig. Red foot marks.

Stand comfortably erect, head forward facing (eyes level with their reflection in mirror opposite), back clear of rear wall. Measurement from floor to datum probe at vertex. Pressure sufficient to flatten the hair but NOT the scalp.



Figure 39. Stature.

No. 5. WAIST HEIGHT

(949)

Rig. Red foot marks.

Stand comfortably erect, shoulders relaxed, arms by the sides. Measurement from the floor to datum probe at the level of the left waist mark.

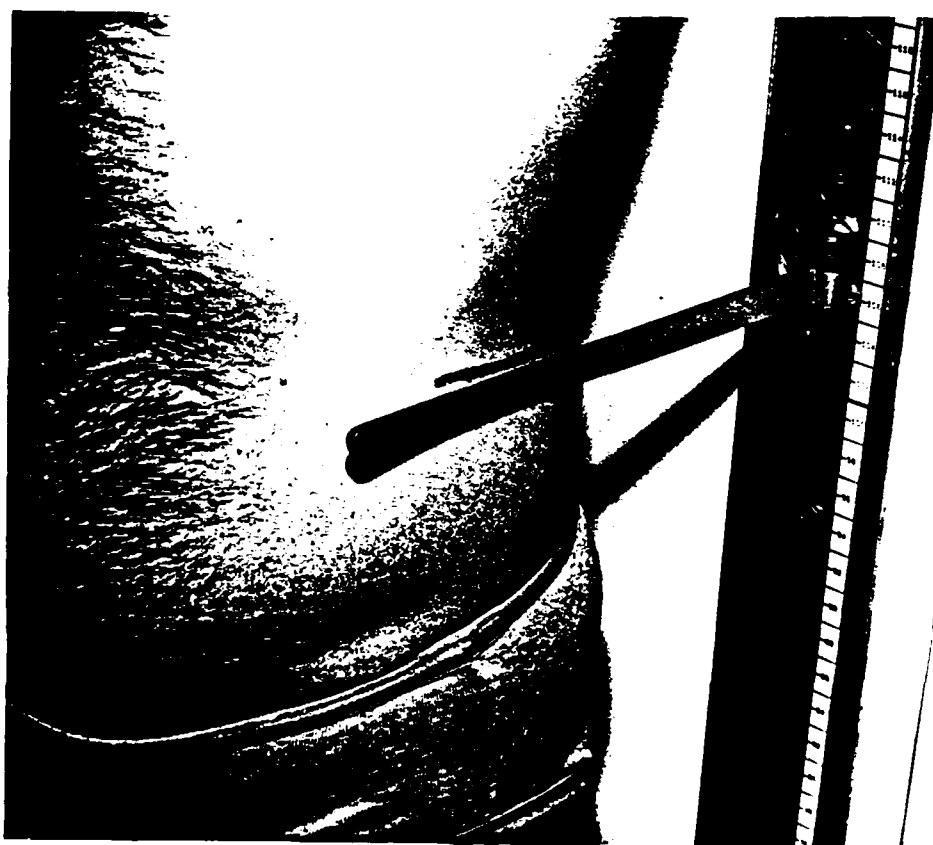


Figure 40. Waist height.

No. 6. CROTCH HEIGHT

(249)

Rig. Red foot marks.

Stand comfortably erect, back to rear wall, feet approximately 6 in. (15.24 cm) apart. Datum probe placed firmly into perineum without accommodating the upper thigh, buttocks, or genitalia.

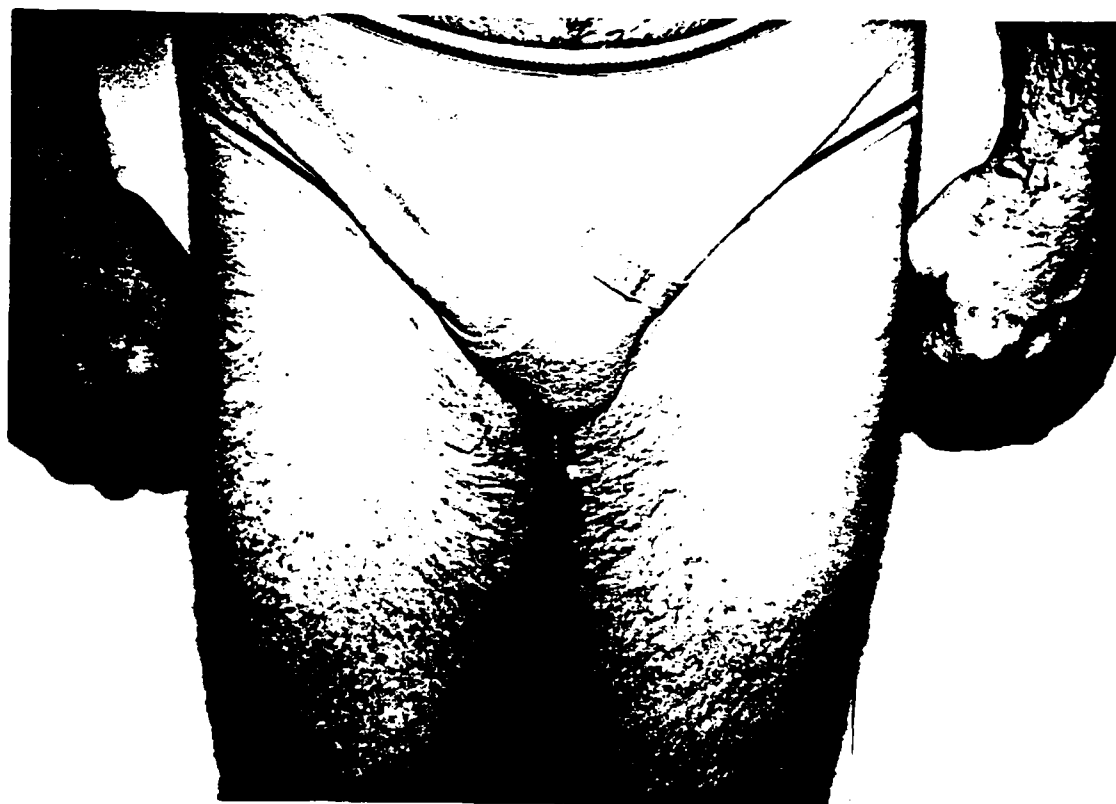


Figure 41. Crotch height.

No. 7. VERTICAL TRUNK CIRCUMFERENCE (916)

Tape. Stand on blue cross in front of rear wall mirror.

Stand comfortably erect, shoulders relaxed, arms by the sides. Pass tape over left shoulder adjacent to the shoulder mark, down between the buttocks, through the crotch to left of genitalia and up the front of the body. NB. Tape spans all body hollows. Pass the end of the tape through the metal loop at the beginning of the tape. Measurement taken where tape free end passes through the metal loop. Corresponding right measurement also taken, and both recorded.



Figure 42. Vertical trunk circumference.



No. 8. CHEST CIRCUMFERENCE

(230)

Tape. Stand on blue cross in front of rear wall mirror.

Stand comfortably erect. Tape placed horizontally around the chest at nipple level with the arms raised. Shoulders then relaxed, arms placed by the sides. Check the alignment of tape at the back in mirror image. Measurement where tape ends cross during quiet, shallow respiration.

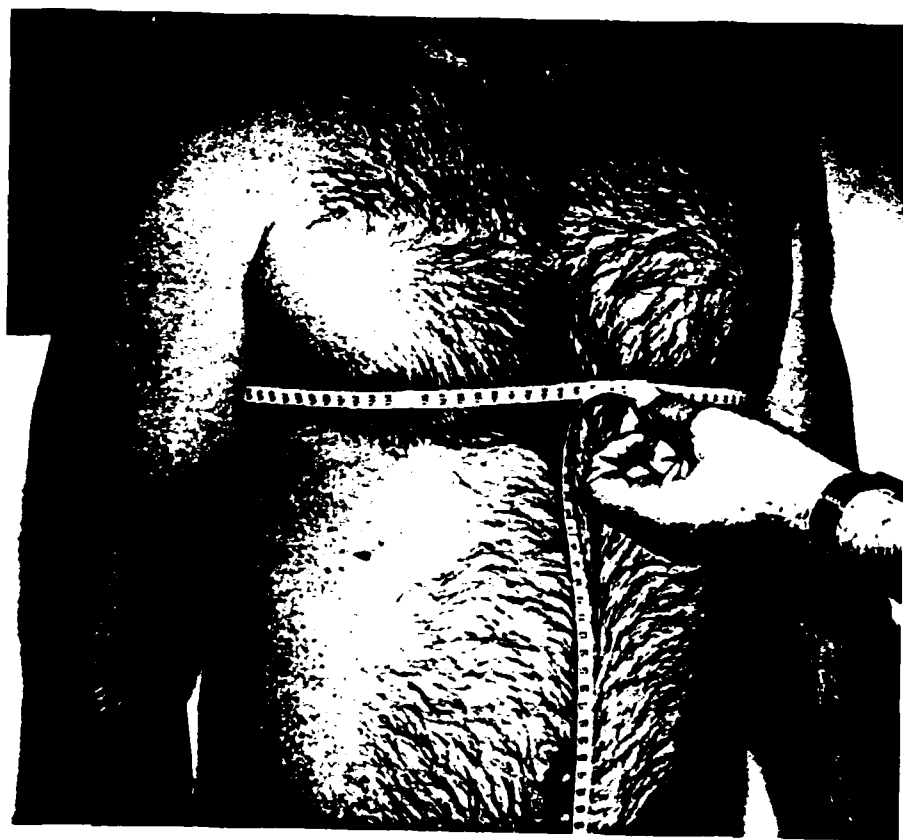


Figure 43. Chest circumference.

No. 9. ELBOW FULLY BENT CIRCUMFERENCE (301)

Tape. Blue foot marks.

Tape placed in crook of left elbow with elbow slightly bent initially, so that the edge of the tape lies in the crease of the elbow. Measurement with tape passing round the maximum prominence of the olecranon with the subject touching left shoulder with left hand.

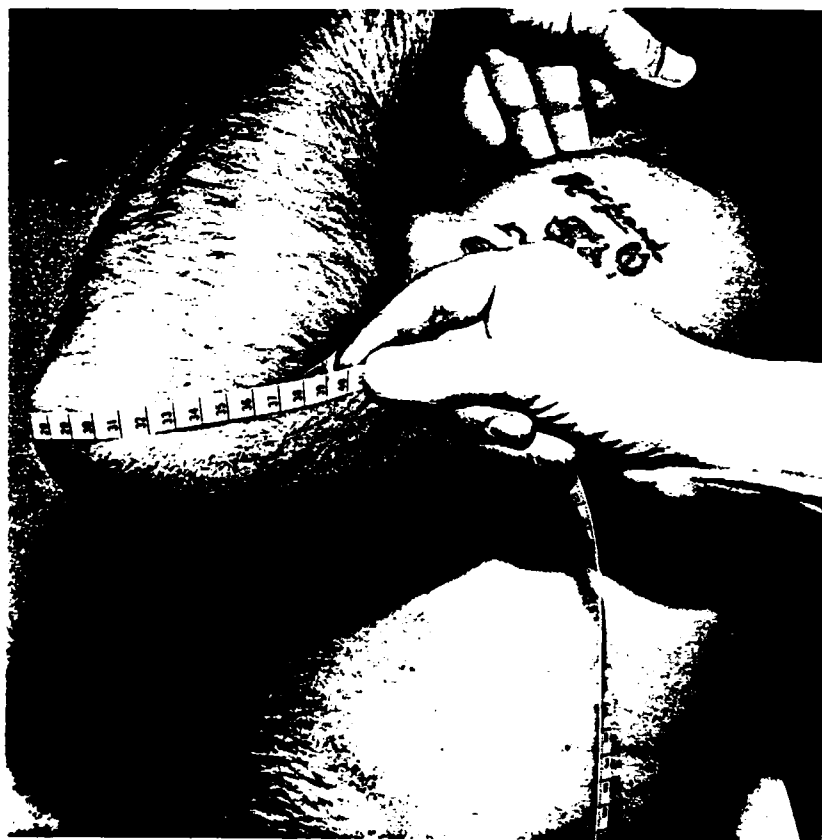


Figure 44. Elbow fully bent circumference.

No. 10. WAIST CIRCUMFERENCE

(931)

Tape. Blue foot marks.

Stand comfortably erect. Tape placed horizontally around waist with the calibrated edge of the tape against the waist marks. Check alignment of the tape. Measurement where tape ends cross during quiet, shallow respiration. Do NOT use excessive tension on the tape.



Figure 45. Waist circumference.

No. 11. BUTTOCK CIRCUMFERENCE

(178)

Tape. Blue foot marks.

Stand comfortably erect. Tape placed horizontally around maximum protuberance of the buttocks. Do NOT include the lower edge seam of briefs, or the genitalia. Measurement where tape ends cross. Do NOT use excessive tension.

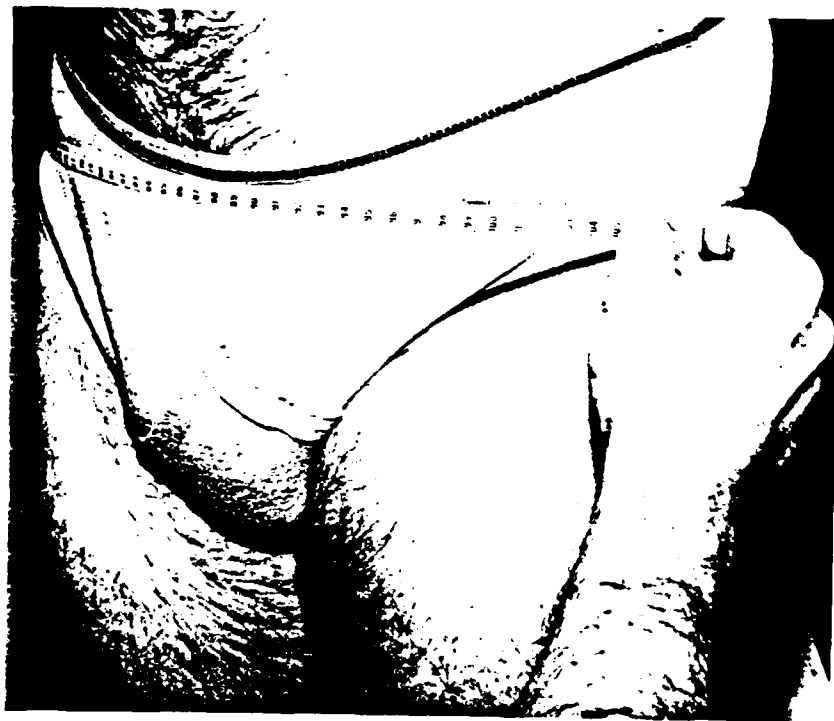


Figure 46. Buttock circumference.

No. 12. THIGH CIRCUMFERENCE

(852)

Tape. Blue foot marks.

Stand comfortably erect. Place tape horizontally around left thigh immediately below gluteal fold. Measurement where tape ends cross. Do NOT use excessive tension.

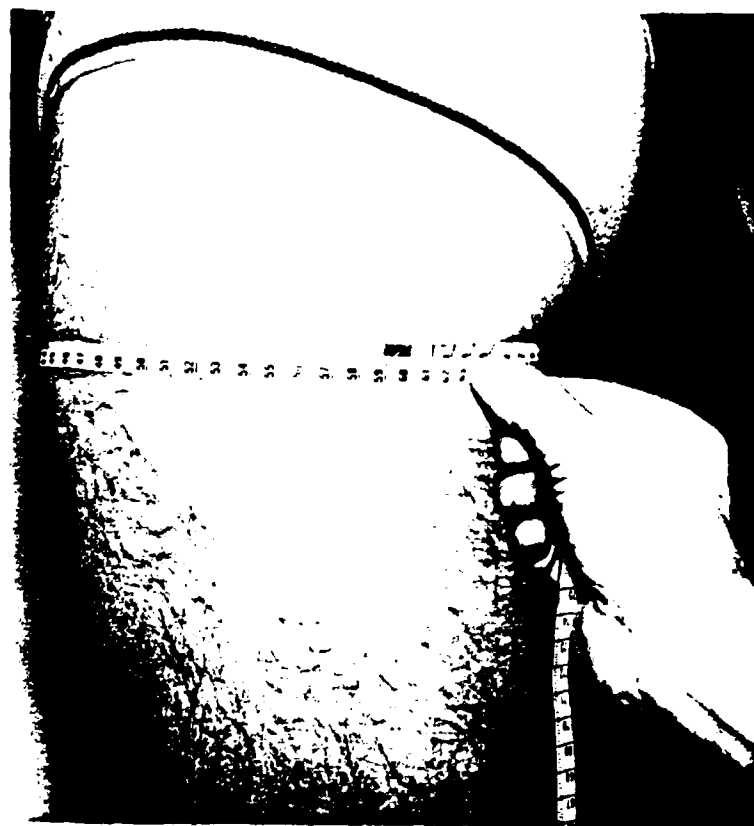


Figure 47. Thigh circumference.

No. 13. KNEE FULLY BENT CIRCUMFERENCE (516)

Tape. Blue foot marks.

Tape placed around left knee with edge of tape in the crease behind the knee with the knee slightly bent initially. Measurement with tape passing over the maximum prominence of the femoral condyles with the subject in a squatting position with the left knee fully bent.



Figure 48. Knee fully bent circumference.

No. 14. LOWER THIGH CIRCUMFERENCE (561)

Tape. Stand on stool.

Stand comfortably erect, weight placed equally on both feet. Tape placed horizontally around left thigh with calibrated edge of tape against the knee mark. Check alignment of tape. Do NOT use excessive tension. Measurement where tape ends cross.



Figure 49. Lower thigh circumference.

No. 15. CALF CIRCUMFERENCE

(207)

Tape. Stand on stool.

Stand comfortably erect, weight placed equally on both feet. Tape placed horizontally around maximum circumference of left calf. Do NOT use excessive tension. Measurement where tape ends cross.



Figure 50. Calf circumference.



No. 16. ANKLE CIRCUMFERENCE

(058)

Tape. Stand on stool.

Stand comfortably erect. Tape placed horizontally around minimum circumference of left ankle just above the ankle bones. Measurement where tape ends cross.



Figure 51. Ankle circumference.

## BODY MEASUREMENTS - SITTING

### No. 17. BUTTOCK - HEEL LENGTH (191)

Rig. Sit on floor at black cross.

Sit on floor, back to end wall, both legs straight, buttocks pushed back into wall as far as possible. Measurement from end wall to the heel block in light contact with left heel, using scale on rig floor. NB. For clarity only, illustration shows right leg flexed.



Figure 52. Buttock - heel length.

No. 18. CERVICALE HEIGHT

(220)

Rig. Stool at red lines. Sit on stool facing end wall.

Sit comfortably erect, head forward facing towards end wall, shoulders relaxed. Elbows placed by the sides, hands resting lightly on thighs. Measurement from the floor to datum probe at cervicale mark. NB. Stool height required to be deducted from this measurement.



Figure 53. Cervicale height.

No. 19. SITTING HEIGHT

(758)

Rig. Stool at red lines. Sit on stool with back to rear wall.

Sit comfortably erect, back towards but clear of rear wall, head forward facing, eyes level with their reflection in mirror opposite. Elbows lightly against sides with hands resting on thighs. Measurement from floor to datum probe at vertex. Pressure sufficient to flatten hair but NOT scalp. NB. Stool height required to be deducted from this measurement.

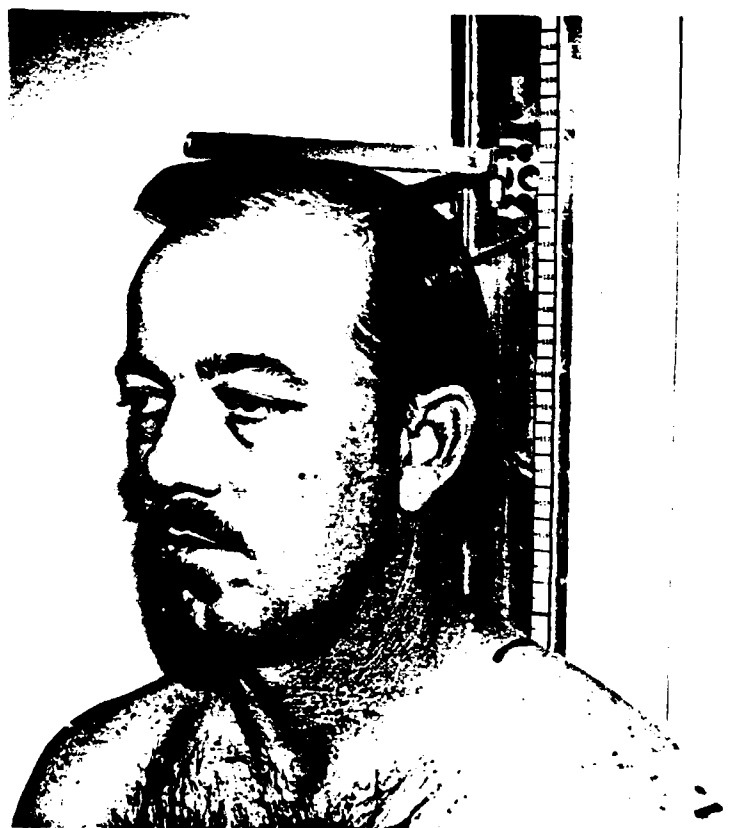


Figure 54. Sitting height.

No. 20. MID - SHOULDER HEIGHT

(612)

Rig. Stool at red lines. Sit on stool, back to rear wall.

Sit comfortably erect, back towards but clear of the rear wall, shoulders relaxed, head forward facing. Elbows lightly against sides with hands resting on thighs. Measurement from floor to datum probe at left shoulder mark. Pressure insufficient to indent the skin. NB. Stool height required to be deducted from this measurement.



Figure 55. Mid - shoulder height.

No. 21. ACROMIAL HEIGHT

(025)

Rig. Stool at red lines. Sit on stool, back to rear wall.

Sit comfortably erect, back towards but clear of the rear wall, shoulders relaxed, head forward facing. Elbows lightly against sides with hands resting on thighs. Measurement from floor to datum probe at left acromion mark. Pressure insufficient to indent the skin. NB. Stool height required to be deducted from this measurement.

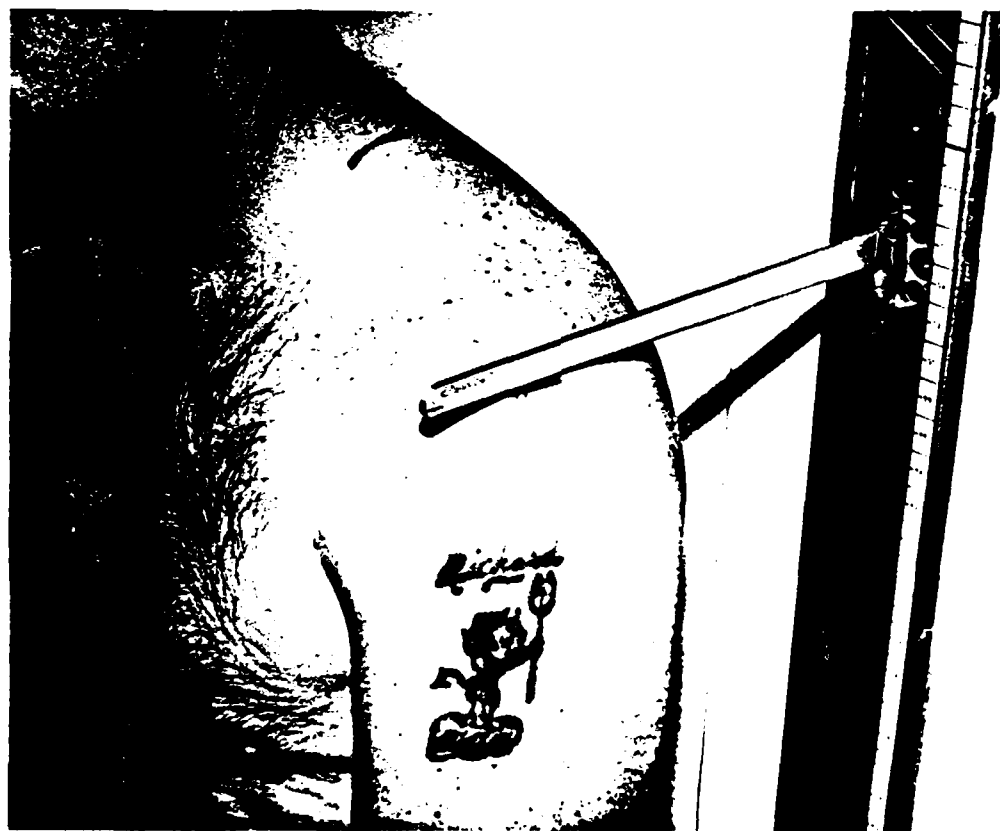


Figure 56. Acromial height.

No. 22. ELBOW REST HEIGHT

(312)

Rig. Stool at red lines. Sit on stool, back to rear wall.

Sit comfortably erect, back towards but clear of the rear wall, shoulders relaxed. Elbows lightly against sides with forearms horizontal. Measurement from floor to datum probe at the lower border of the olecranon process. NB. Stool height required to be deducted from this measurement.

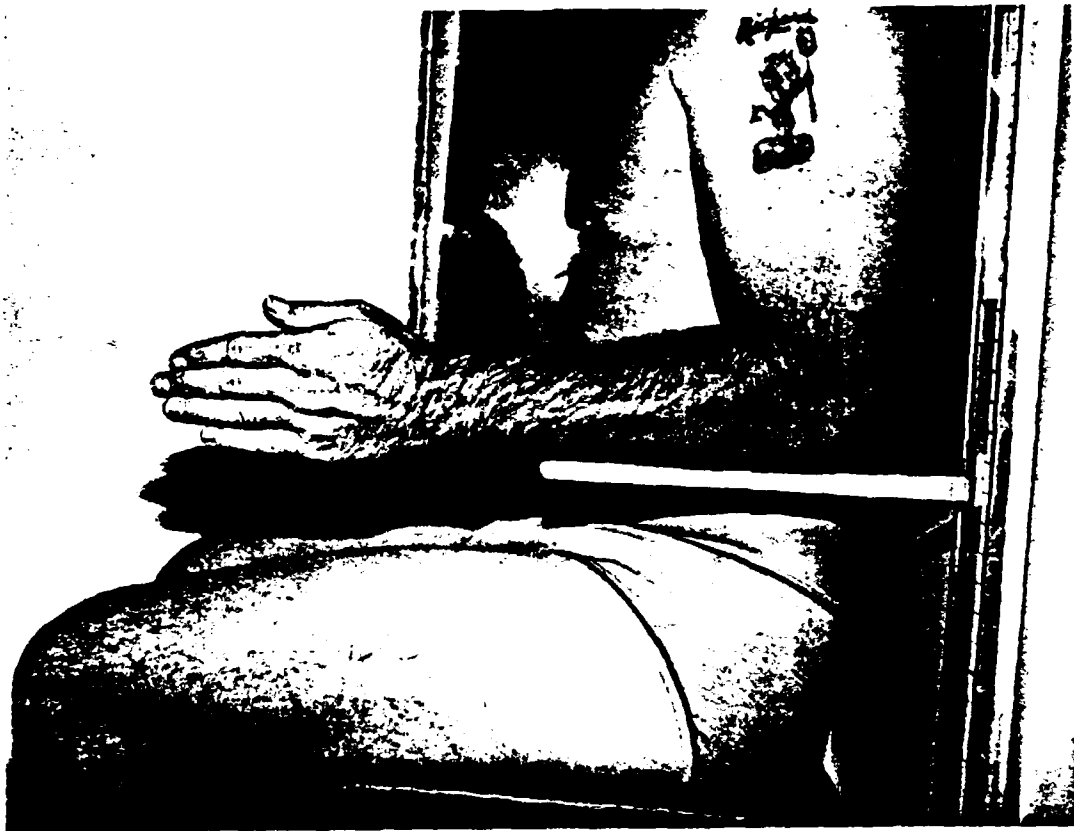


Figure 57. Elbow rest height.

Rig. Stool at green lines. Sit on stool, back to rear wall.

Sit comfortably erect, back towards but clear of the rear wall, shoulders relaxed. Elbows lightly against sides with hands resting on thighs. Light pressure exerted by the right deltoid against the perspex panel such that an area of skin of approximately 1 in. (2.54 cm) x 1 in. (2.54 cm) across over the muscle is in contact with the perspex (monitored from mirror). Measurement from the end wall to the datum probe at maximum prominence of the left deltoid muscle.



Figure 58. Bi - deltoid breadth.



No. 24. VERTICAL FUNCTIONAL REACH (914)

Rig. Stool at green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against the end wall. Left arm raised vertically to maximum reach without raising the buttocks. Forefinger and thumb opposed and thumb in line with extended arm. Measurement from floor to datum probe at tip of left thumb. NB. Stool height required to be deducted from this measurement.



Figure 59, Vertical functional reach.

No. 25. FUNCTIONAL REACH

(867)

Rig. Stool at green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against the end wall perspex panel. Ensure equal pressure of shoulder blades against the panel (monitored in the mirror). Arms extended horizontally with forefinger and thumb opposed, thumb in line with extended arms. Measurement from end wall to datum probe at tip of left thumb.

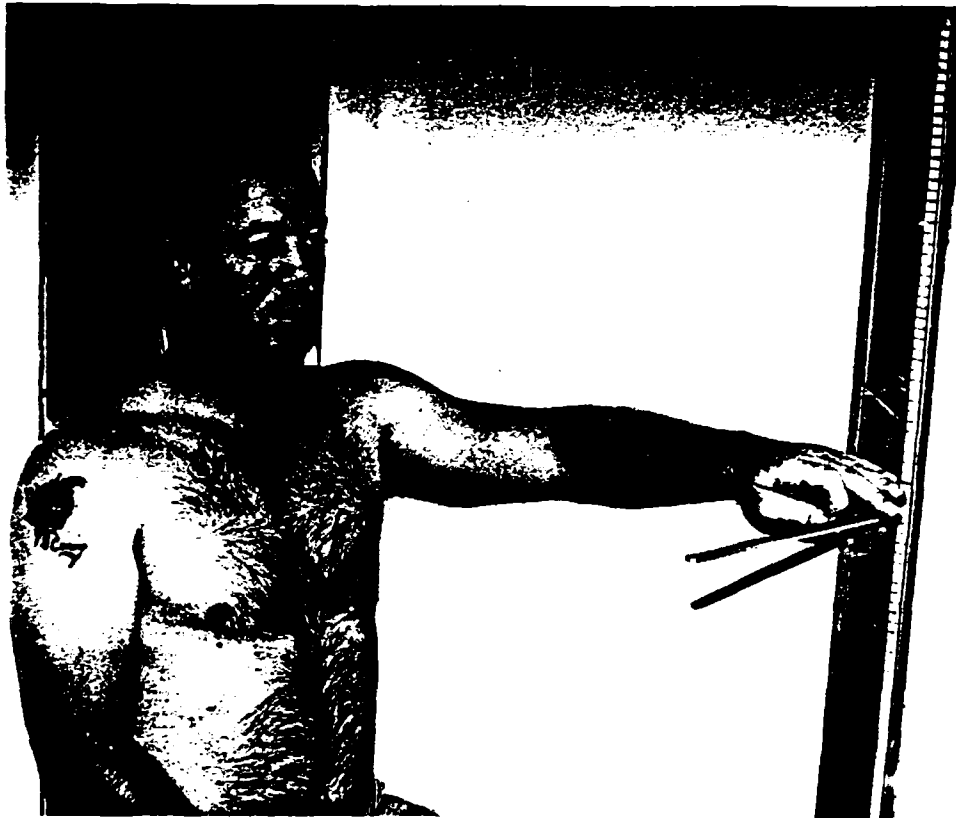


Figure 60. Functional reach.

No. 26. CHEST DEPTH

(236)

Rig. Stool at green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against end wall perspex panel. Ensure equal pressure of shoulder blades against the panel (monitored in the mirror). Elbows lightly against sides, hands resting on thighs. Measurement from end wall to datum probe at maximum protrusion of chest on a line transecting the left nipple.



Figure 61. Chest depth.

No. 27. ABDOMINAL EXTENSION TO WALL (STOMACH DEPTH) (021)

Rig. Stool at green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against end wall perspex panel. Ensure equal pressure of shoulder blades against the panel (monitored in the mirror). Arms held comfortably by the sides. Measurement from the end wall to datum probe at maximum protrusion of abdomen.

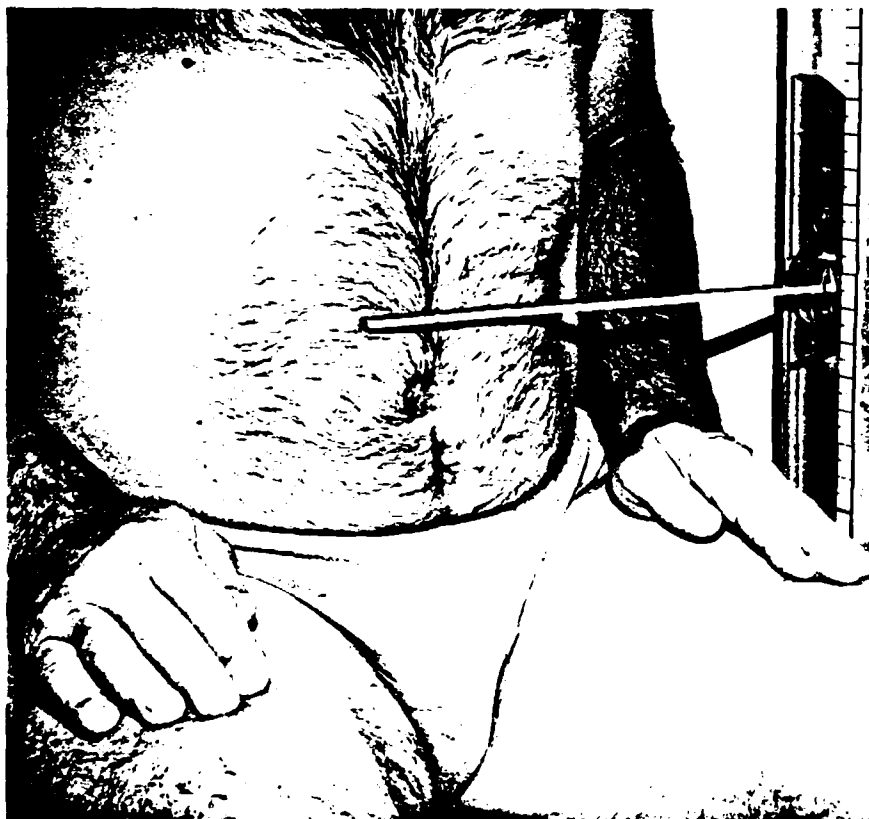


Figure 62. Abdominal extension to wall (stomach depth).

No. 28. THIGH CLEARANCE HEIGHT

(856)

Rig. Stool at green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against end wall, shins vertical, feet flat on the floor. Measurement from floor to datum probe at highest point of the upper surface of the left thigh. NB. Stool height required to be deducted from this measurement.

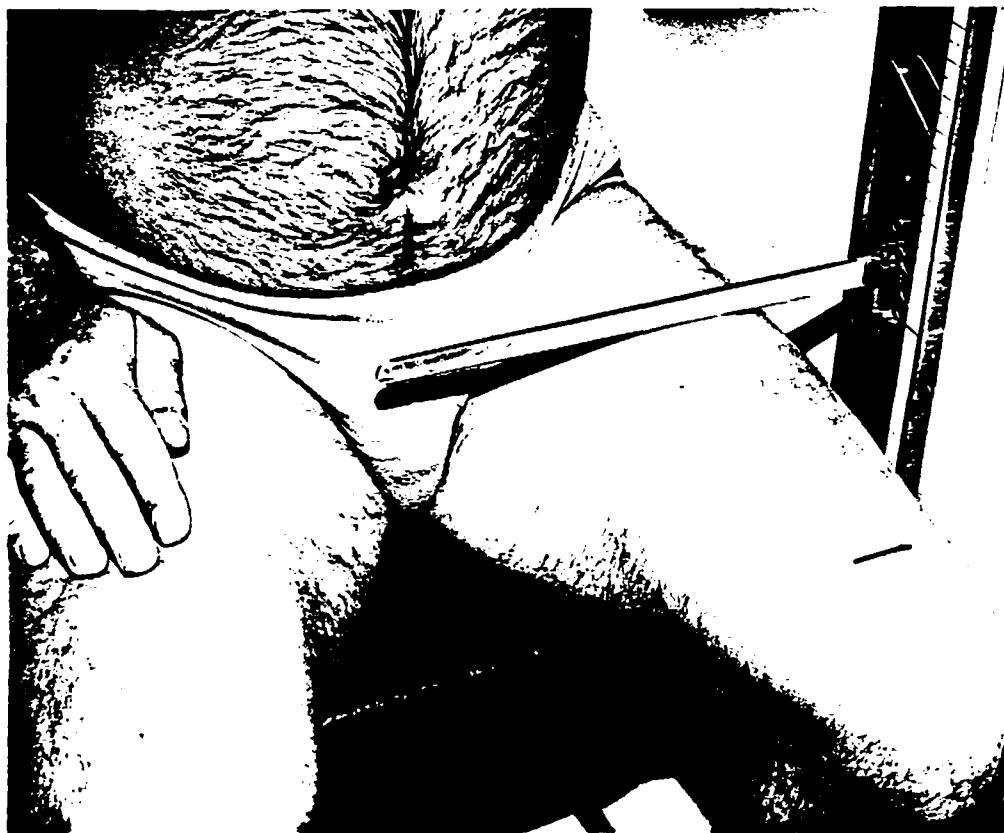


Figure 63. Thigh clearance height.

No. 29. KNEE HEIGHT

(529)

Rig. Stool at green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against end wall, thighs parallel to the rear wall, shins vertical and feet flat on the floor. Measurement from floor to datum probe at left knee mark.

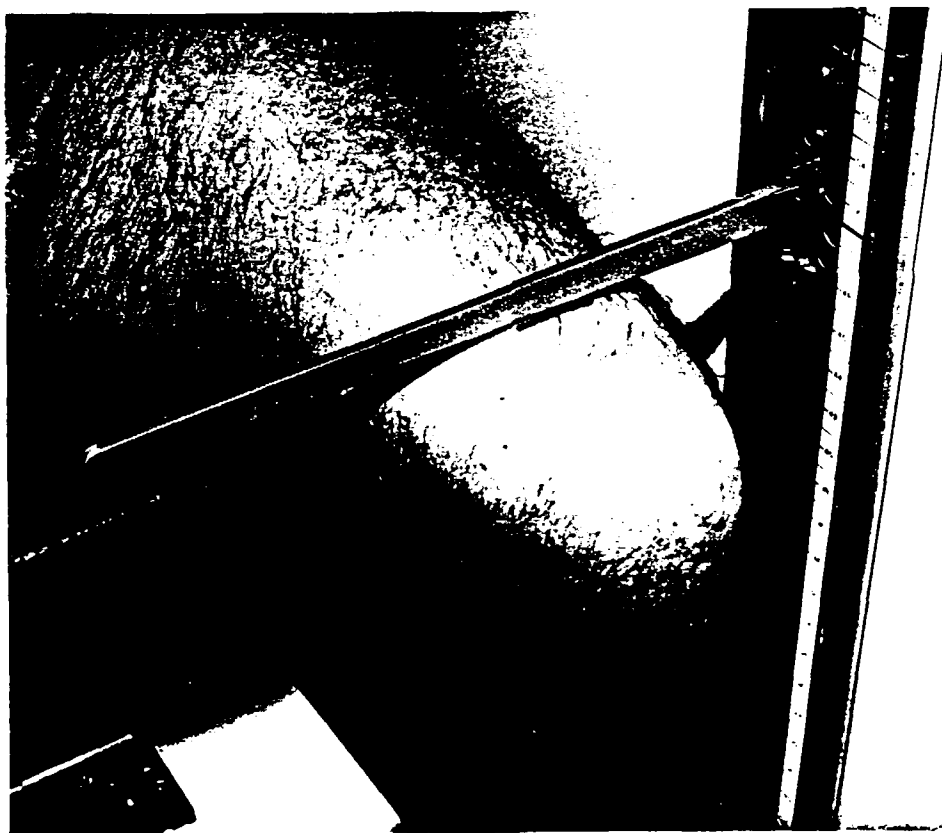


Figure 64. Knee height.

No. 30. BUTTOCK - KNEE LENGTH

(194)

Rig. Stool on green lines. Sit on stool, back to end wall.

Sit comfortably erect, back and buttocks firmly against end wall, thighs parallel to the rear wall, shins vertical and feet flat on the floor. Knee block placed vertically on left knee against the patella (NOT necessarily in contact with the shin). Measurement from end wall to datum probe at inside surface of knee block extension (knee block datum face).



Figure 65. Buttock - knee length.

No. 31. STOOL HEIGHT

(816)

Rig. Stool at green lines. No subject.

Measurement from floor to datum probe at stool sitting surface. NB.  
Stool height remains at that initially set for the subject for ALL  
sitting measurement.

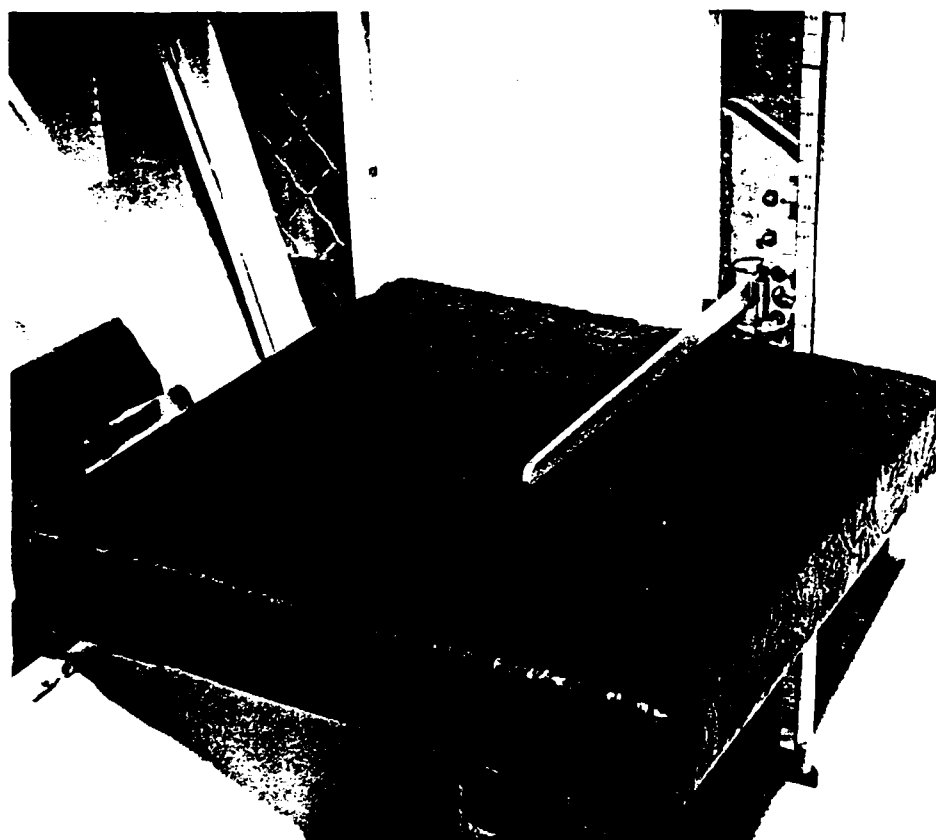


Figure 66. Stool height.



No. 32. HIP BREADTH

(459)

Caliper. Stool clear of walls. Sit on stool facing rear wall.

Sit comfortably erect, shoulders relaxed, knees together, elbows lightly at sides and hands resting on thighs. Measurement with datum faces of body caliper in light contact with the buttocks at their widest point.

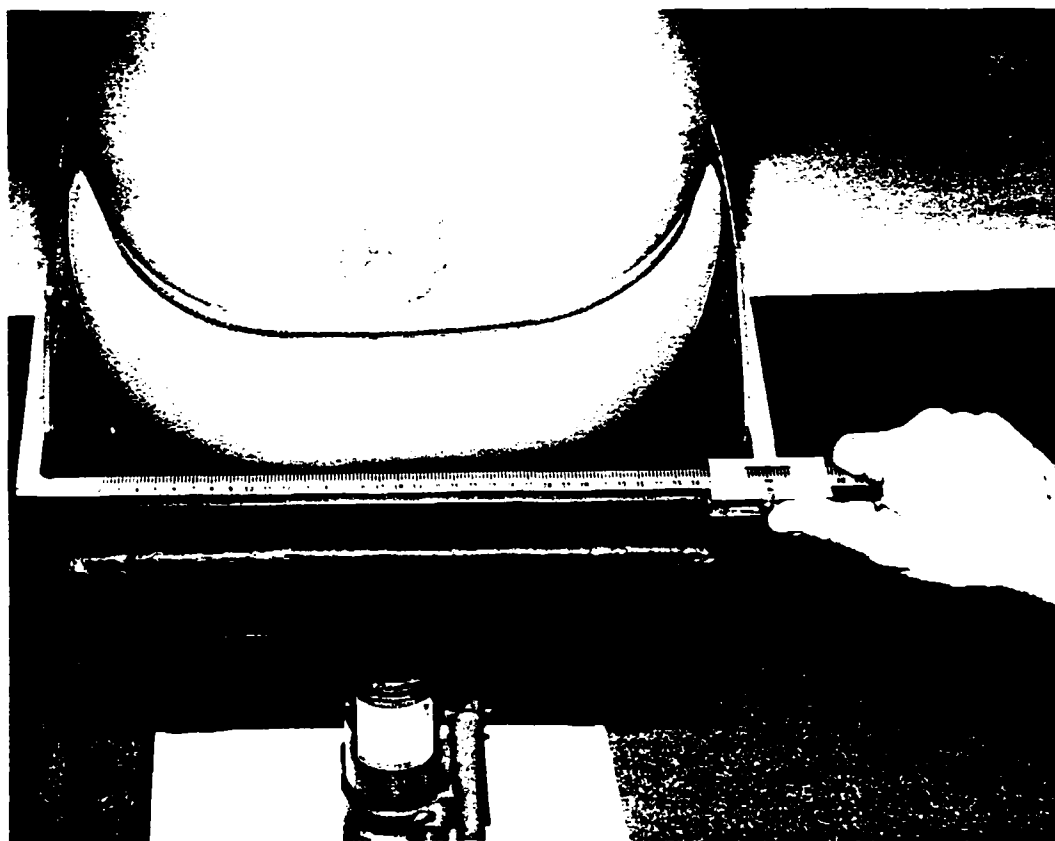


Figure 67. Hip breadth.

## BODY MEASUREMENTS - HEAD/NECK

### NOTE

For ALL head rig measurements, stool placed at black lines. Sit on stool, back towards but clear of end wall. Head forward facing, eyes level with their reflection in mirror opposite.

#### No. 33. TRAGION - VERTEX LENGTH (882).

Head Rig.

Sitting, head in contact with the head measuring rig datum faces. Measurement of vertical distance from roof of head box to datum edge of pointer aligned with left tragon.

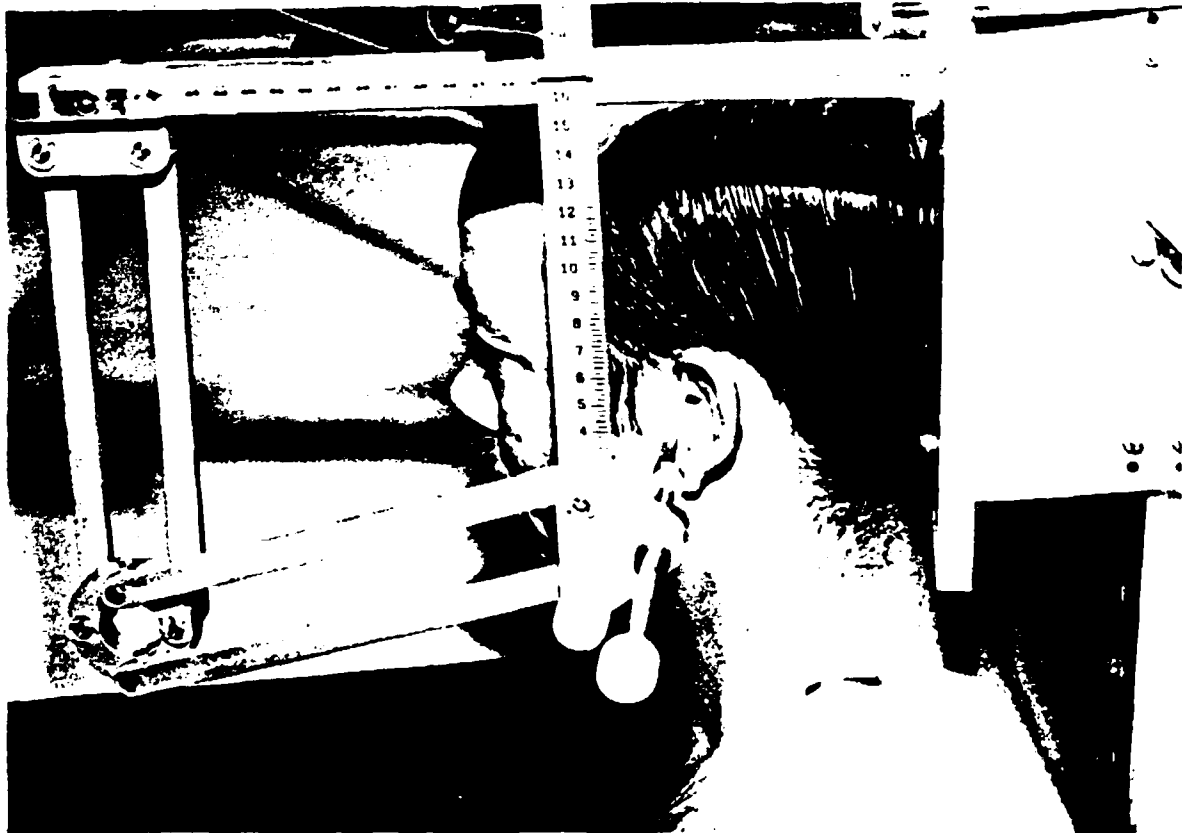


Figure 68. Tragon - vertex length.

No. 34. TRAGION - WALL LENGTH

(884)

Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of horizontal distance from back of head box to datum edge  
of pointer aligned with left tragon.

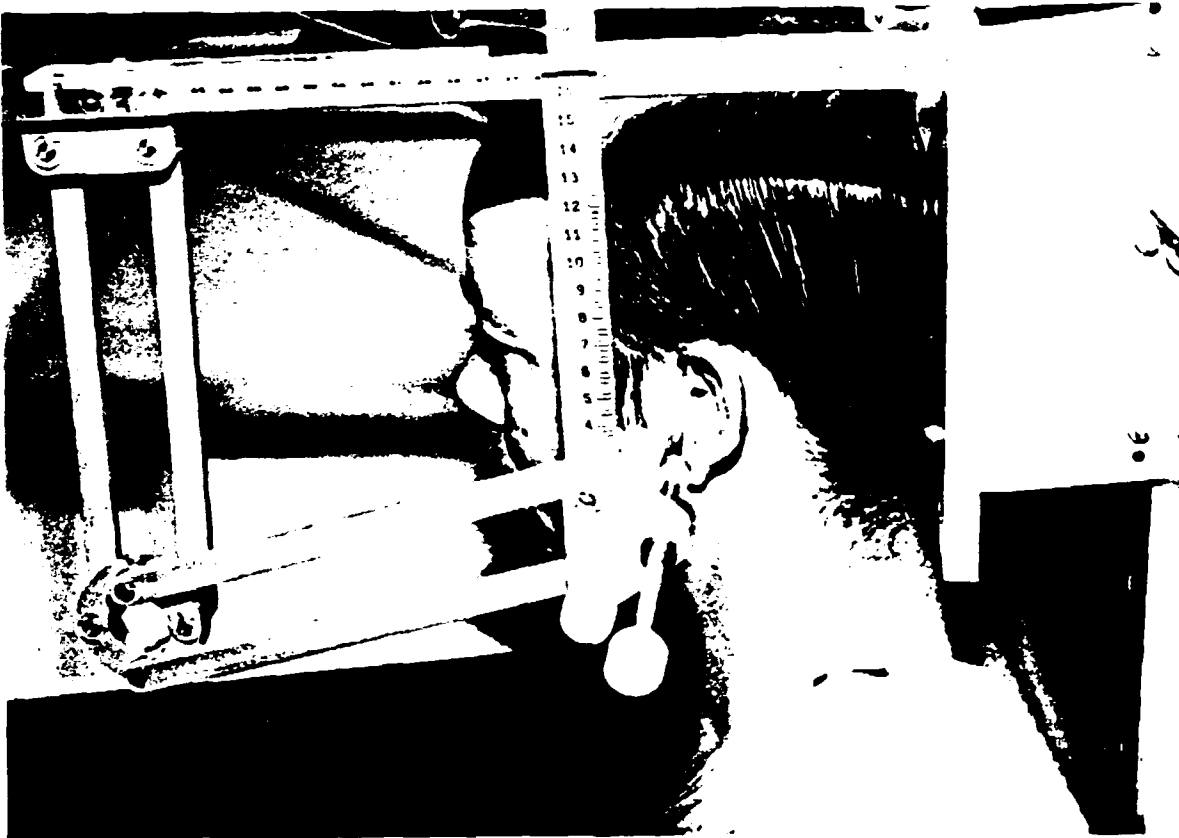


Figure 69. Tragion - wall length.

No. 35. GLABELLA - VERTEX LENGTH

(389)

Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of vertical distance from roof of head box to datum edge  
of pointer in light contact with the maximum prominence of the  
glabella (brow ridge).

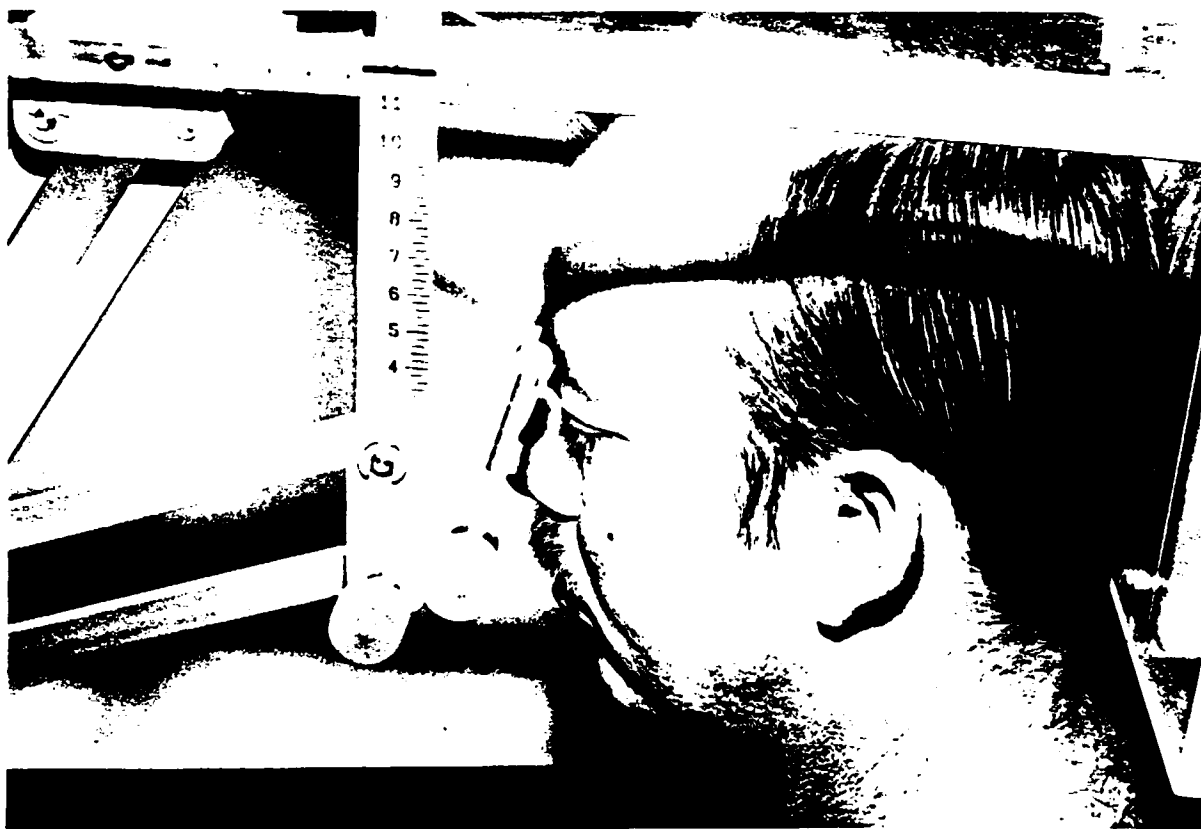


Figure 70. Glabella - vertex length.

No. 36. GLABELLA - WALL LENGTH (HEAD LENGTH) (391)

Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of horizontal distance from back of head box to datum face  
of pointer in light contact with the maximum prominence of the  
glabella (brow ridge).



Figure 71. Glabella - wall length (head length).

No. 37. PUPIL - VERTEX LENGTH

(289)

Head rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of vertical distance from roof of head box to datum edge  
of pointer, raised until subject sees datum edge of the pointer bisect  
the left pupil in the vertical mirror opposite.



Figure 72. Pupil - vertex length.

No. 38. SELLION (NASION) - VERTEX LENGTH (739)

Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of vertical distance from roof of head box to datum edge  
of pointer in light contact with the deepest indentation of the sel-  
lion or nasion (bridge of nose).



Figure 73. Sellion (nasion) - vertex length.

No. 39. SELLION (NASION) - WALL LENGTH (741)

Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of horizontal distance from back of head box to datum edge  
of pointer in light contact with the deepest indentation of the sel-  
lion or nasion (bridge of nose).



Figure 74. Sellion (nasion) - wall length.



Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of vertical distance from roof of head box to datum face  
of pointer in light contact with the lower surface of the chin.



Figure 75. Menton - vertex length.

No. 41. MENTON - WALL LENGTH

(597)

Head Rig.

Sitting, head in contact with the head measuring rig datum faces.  
Measurement of horizontal distance from back of head box to datum face  
of pointer in light contact with the maximum protuberance of the front  
of the chin.



Figure 76. Menton - wall length.

No. 42. MAXIMUM HEAD DIAGONAL (Menton to Occiput) (437)

Head Caliper. Stool clear of walls. Sit on stool.

Comfortably erect, head forward facing. Fixed disc head of caliper placed on the chin with jaw closed, and the other disc head moved about the occiput to determine the position of maximum diagonal. Pressure sufficient to flatten the hair. Measurement from occiput to fixed disc head of caliper in light contact with the chin.



Figure 77. Maximum head diagonal (Menton to occiput).

No. 43. HEAD BREADTH

(427)

Head Caliper. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement with disc heads of the caliper placed over the maximum breadth of the head. Pressure sufficient to flatten the hair.

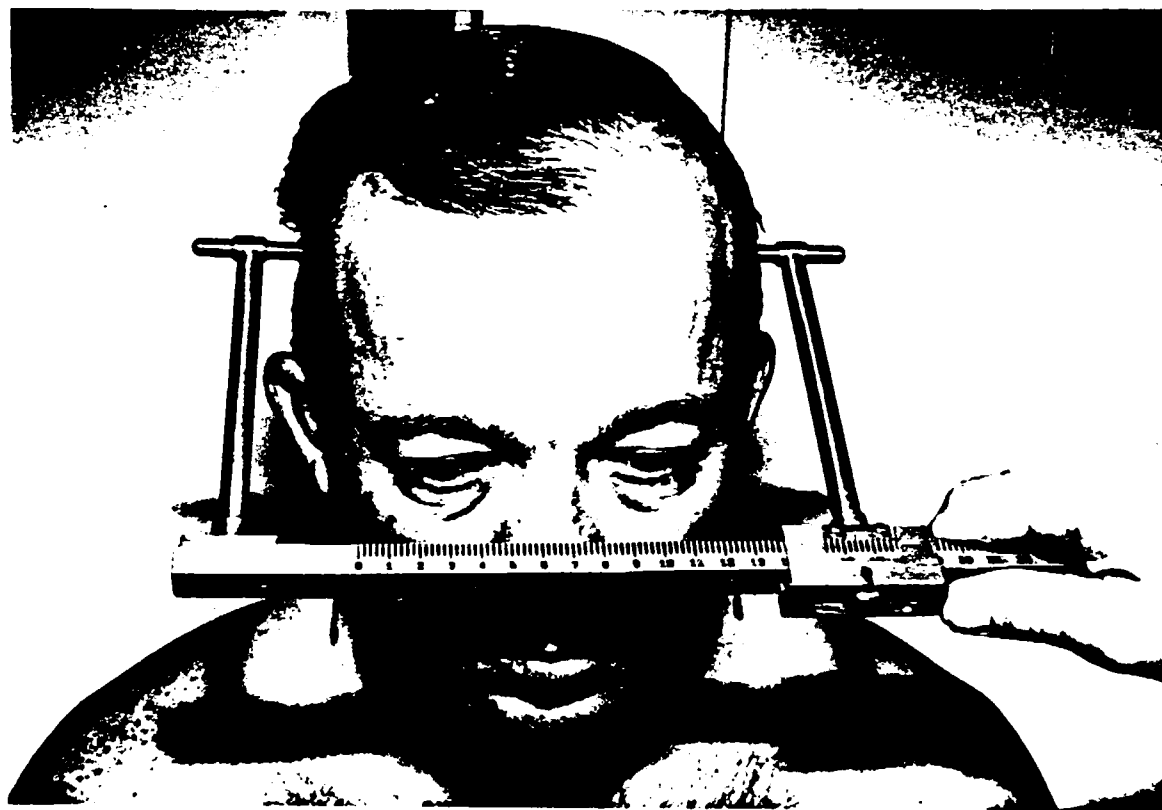


Figure 78. Head breadth.

No. 44. BI - TRAGION BREADTH

(142)

Head Caliper. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement with the ball ends of the caliper in light contact with each trigion.



Figure 79. Bi - trigion breadth.

No. 45. BI - OCULAR BREADTH

(138)

Caliper. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement horizontally with the datum edges of the caliper in light contact with the outer corner of each eye.

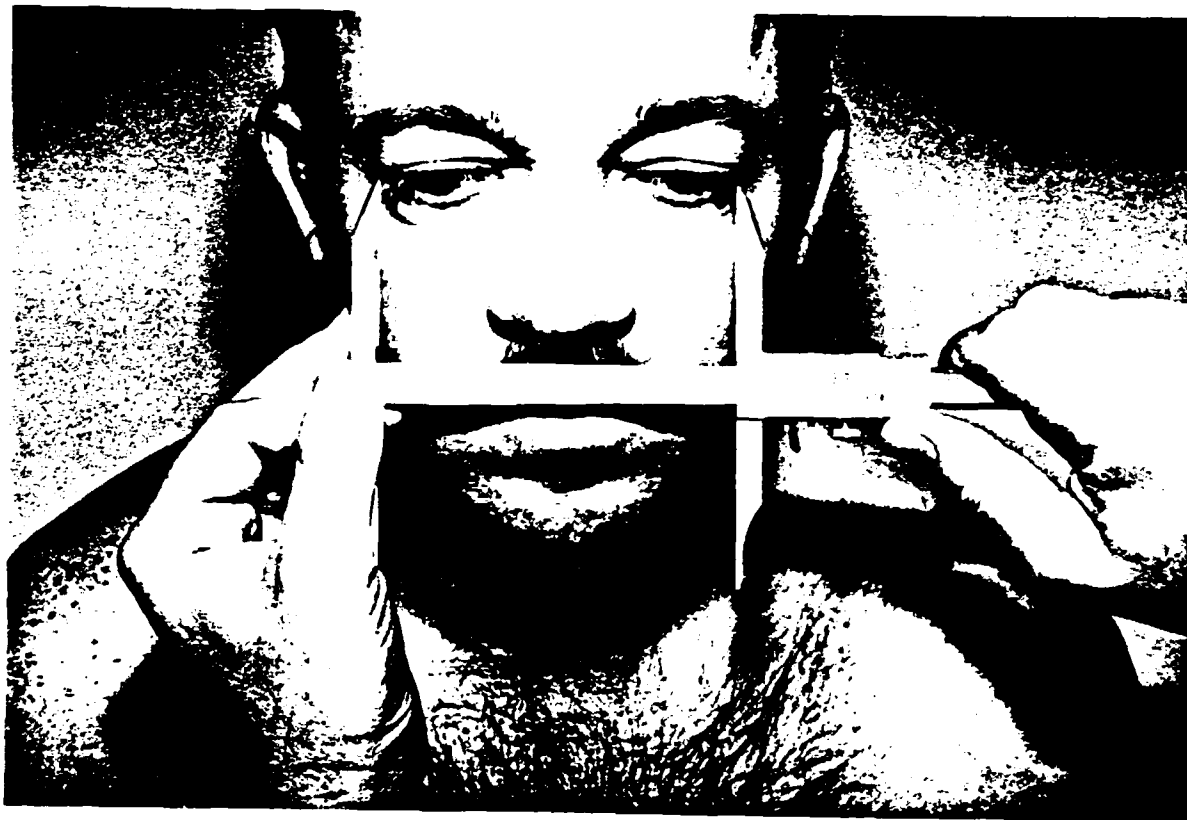


Figure 80. Bi - ocular breadth.

No. 46. BI - ZYGOMATIC BREADTH (FACE BREADTH) (165)

Caliper. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing with the face in repose. Measurement horizontally with the datum ends of the caliper arms in light contact with the maximum prominence of each cheek bone.



Figure 81. Bi - zygomatic breadth (face breadth).

No. 47. LIP LENGTH

(547)

Caliper. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing with the face in repose.  
Measurement horizontally with the datum edges of the caliper in light  
contact with the outer corners of the mouth.



Figure 82. Lip length.



No. 48. MENTON - SUB-NASALE LENGTH (592)

Caliper. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing with the face in repose. Measurement vertically in the midline of the body from one datum edge of the caliper in light contact with the lower extremity of the chin, to the other datum edge of the caliper in light contact with the base of the nasal septum.



Figure 83. Menton - sub-nasale length.

No. 49. HEAD CIRCUMFERENCE

(430)

Tape. Stool clear of walls. sit on stool.

Sit comfortably erect, head forward facing. Measurement with the tape passing horizontally around the head just above the brow ridges and over the occiput. Tape tension sufficient to flatten hair.



Figure 84. Head circumference.

No. 50. BI - TRAGION CORONAL ARC

(144)

Tape. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement from the tragon of one ear vertically over the head to the tragon of the other ear. Tape tension sufficient to flatten hair.

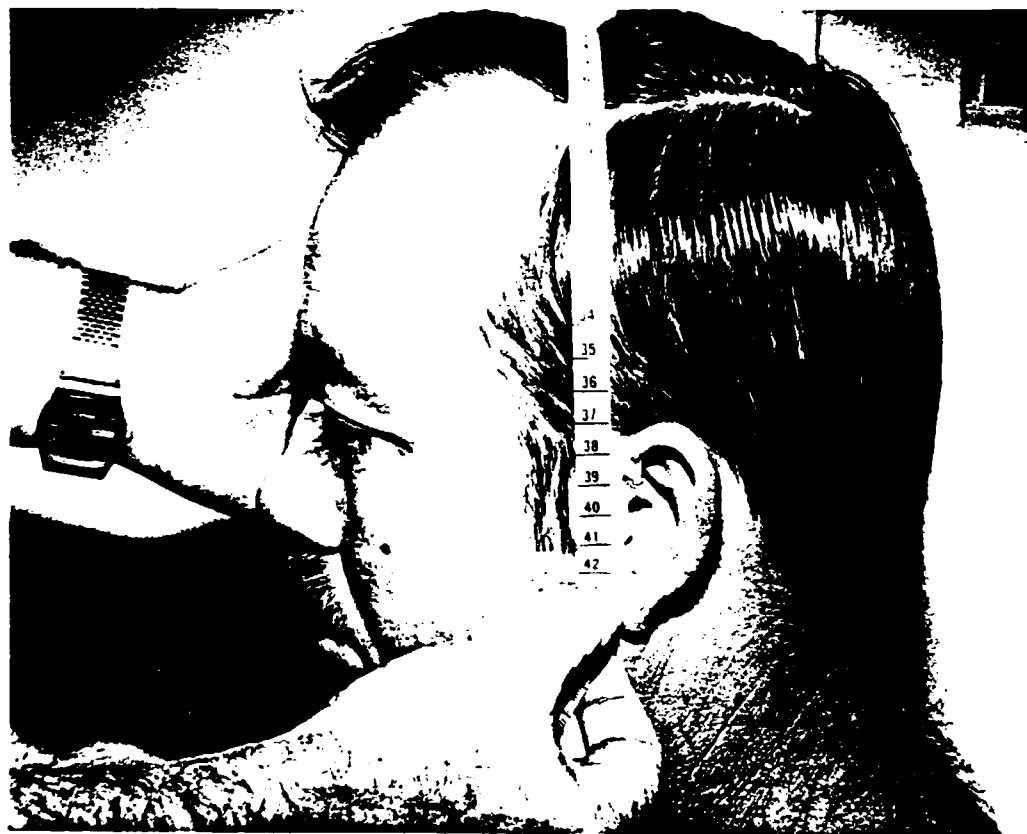


Figure 85. Bi - tragon coronal arc.

No. 51. POSTERIOR NECK LENGTH

(686)

Tape. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement along the skin surface vertically in the midline of the body from the lower edge of the nuchal prominence at the back of the head to the cervicale mark.



Figure 86. Posterior neck length.

No. 52. NECK CIRCUMFERENCE

(639)

Tape. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement with the tape passing around the neck immediately below the larynx, giving a plane of circumference perpendicular to the long axis of the neck.



Figure 87. Neck circumference.

## BODY MEASUREMENTS - HANDS/FEET

### NOTE

ALL measurements carried out with the subject sitting on stool placed clear of the walls.

#### No. 53. HAND BREADTH

(441)

Tape. Stool clear of walls. Sit on stool.

Sit comfortably erect, head forward facing. Measurement with the tape passing around the neck immediately below the larynx, giving a plane of circumference perpendicular to the long axis of the neck.

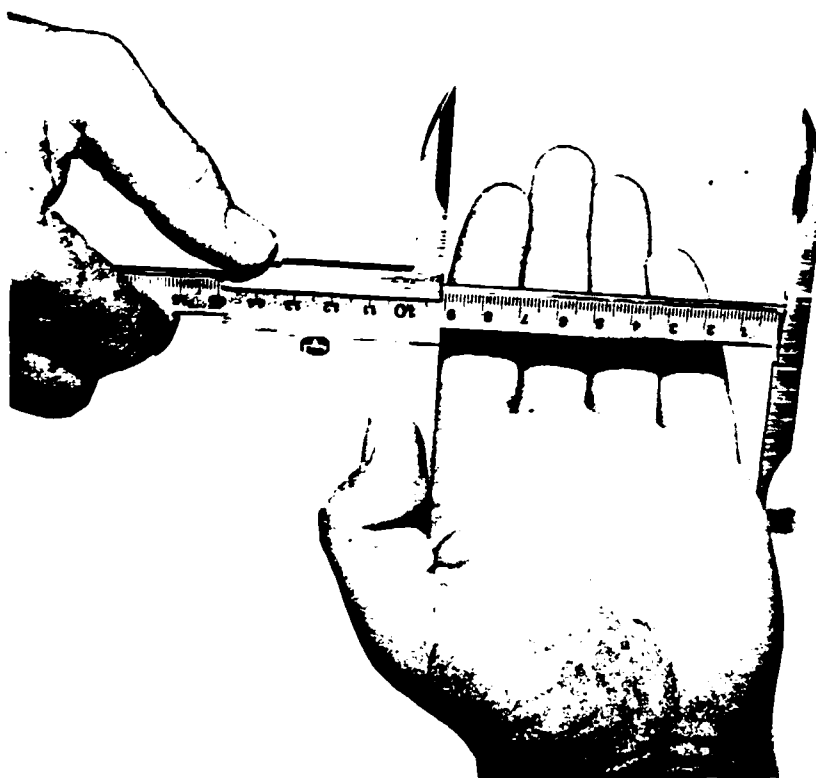


Figure 88. Hand breadth.

No. 54. FOREFINGER LENGTH

(345)

Caliper.

Left hand held outstretched, palm uppermost, with the thumb abducted. Measurement along the long axis of the finger from one datum edge of the caliper in light contact with the crotch of the thumb, to the other datum edge of the caliper in light contact with the tip of the forefinger (index finger, or digit 2).

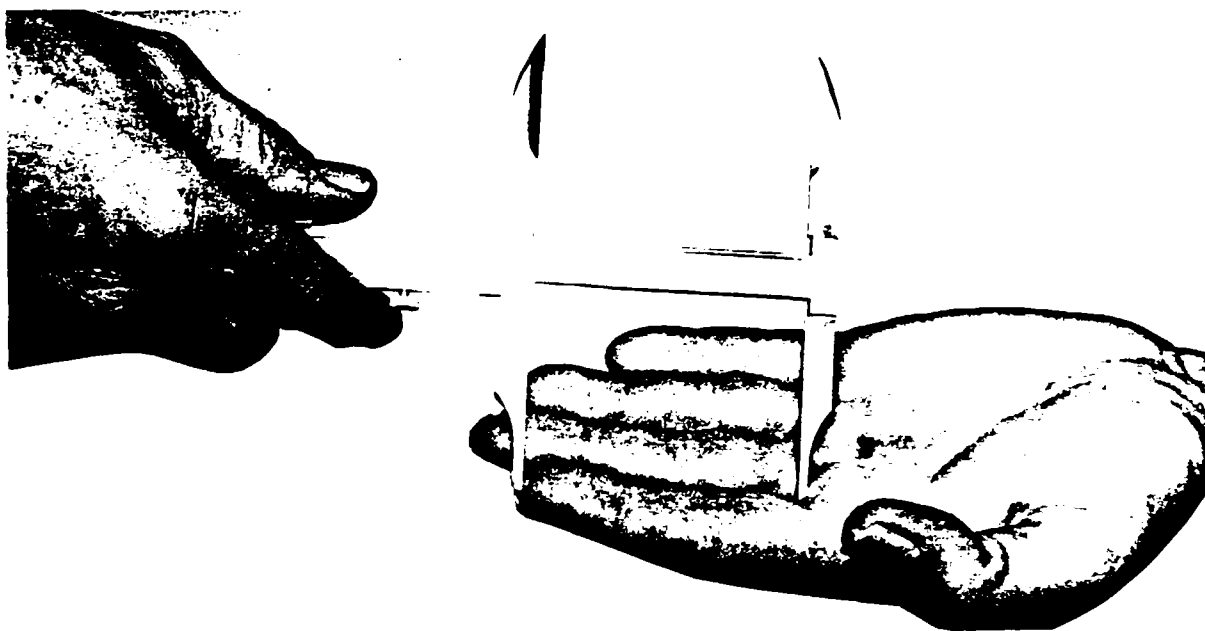


Figure 89. Forefinger length.

No. 55. FINGER LENGTH, DIGIT 3

(346)

Caliper.

Left hand held outstretched, palm uppermost with the fingers parted slightly. Measurement along the axis of the finger from datum edge of caliper in light contact with the web between the index and middle finger, to datum edge of caliper in light contact with the tip of the middle finger (digit 3).

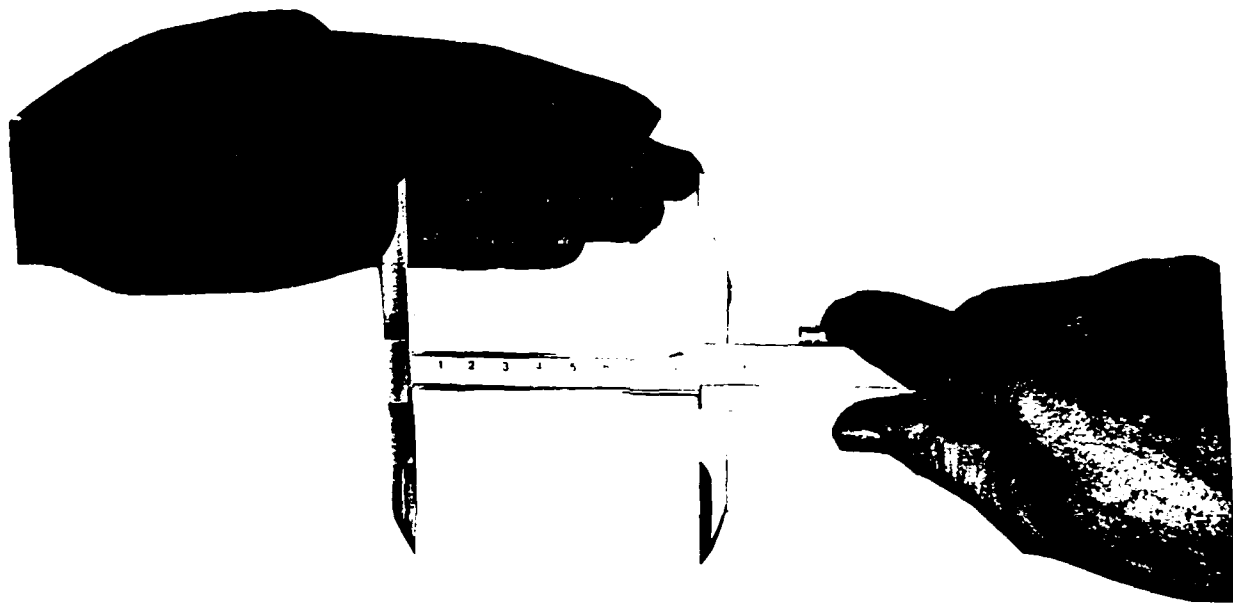


Figure 90. Finger length, digit 3.



No. 56. WRIST CIRCUMFERENCE

(967)

Tape.

Measurement around left wrist with the calibrated edge of the tape lying immediately proximal to the styloid process of the ulna.

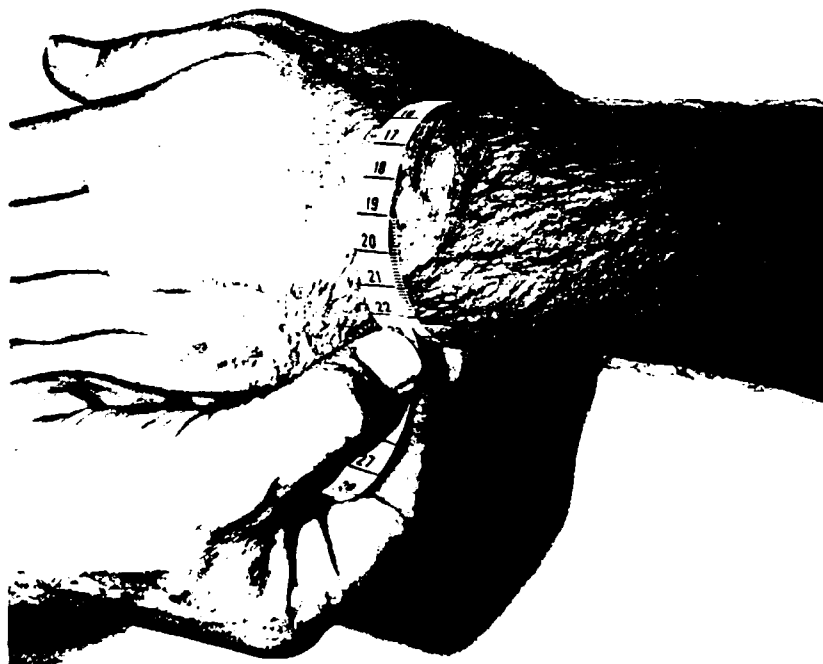


Figure 91. Wrist circumference.

No. 57. HAND CIRCUMFERENCE

(416)

Tape.

Left hand held outstretched, palm uppermost. Measurement around the palm at the level of the distal ends of the metacarpal bones.

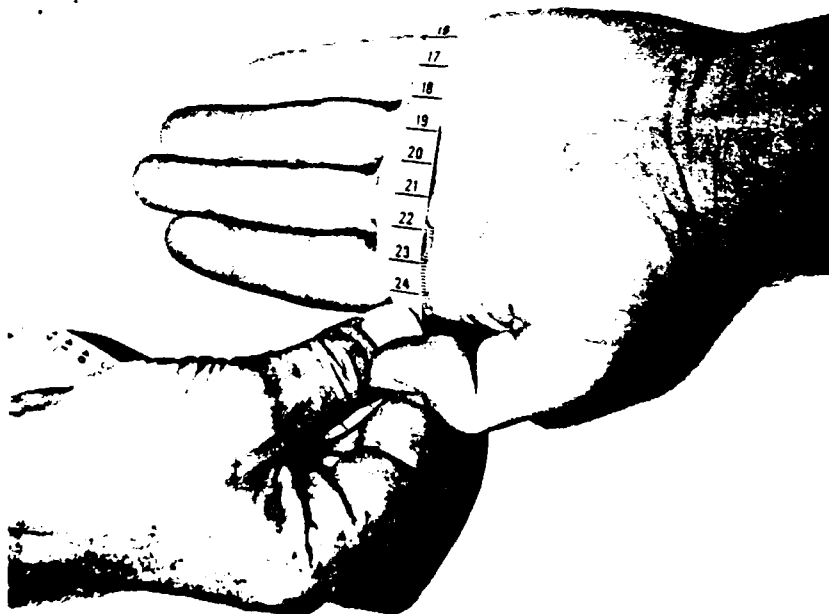


Figure 92. Hand circumference.

AD-A170 298

ANTHROPOMETRY HANDBOOK(U) SCHOOL OF AEROSPACE MEDICINE  
BROOKS AFB TX P H GILL FEB 86 USAFSAM-TR-85-108

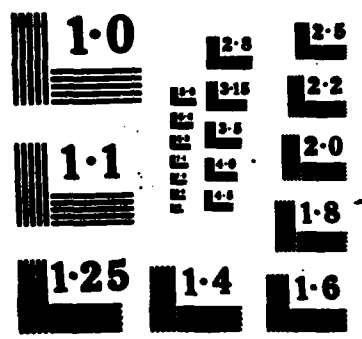
2/2

UNCLASSIFIED

F/G 6/14

NL





No. 58. FOOT LENGTH

(362)

Foot box.

Sit comfortably erect with left foot placed flat in the foot box, with the heel against the back face and the inner side of the foot against the side of the box. Measurement from the back face of the box to datum face of the slide in light contact with the tip of the longest toe.

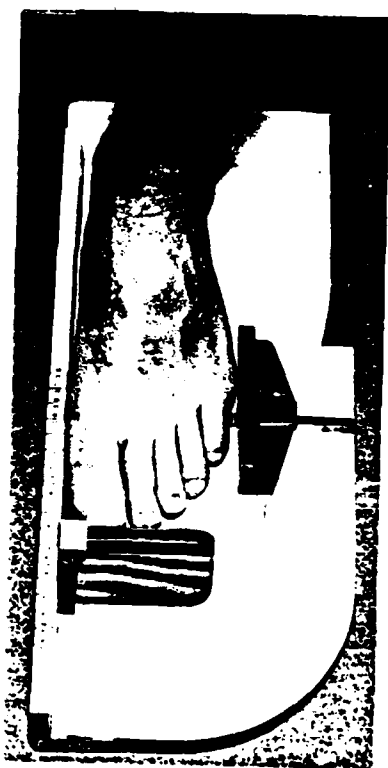


Figure 93. Foot length.

No. 59. FOOT BREADTH

(356)

Foot box.

Sit comfortably erect with the left foot placed flat in the foot box, with the heel against the back face of the box and the inner side of the foot against the side of the box. Measurement from the side of the box to datum face of the slide in light contact with the widest point of the foot.



Figure 94. Foot breadth.

No. 60. BALL OF FOOT CIRCUMFERENCE (097)

Tape.

Sit comfortably erect, feet placed flat on the floor with the shins vertical. Measurement with the tape encircling the ball of the left foot including the ends of the first and fifth metatarsal bones.



Figure 95. Ball of foot circumference.

## BODY MEASUREMENTS - DERIVED MEASURES

### NOTE

These measurements are constructed from other directly recorded body measurements as detailed below. (Not illustrated).

No. 61. EYE HEIGHT, SITTING (330)

Sitting Height (No. 19) less

Pupil - Vertex Length (No. 37).

No. 62. NECK LENGTH (222)

Sitting height (No. 19) less

Cervicale height (No. 18).

Result less

Tragion - Vertex Length (No. 33).

No. 63. UPPER ARM LENGTH (751)

Acromial Height (No. 21) less

Elbow Rest Height (No. 22).

No. 64. HAND LENGTH (420)

Elbow - Fingertip Length (No. 2) less

Elbow - Wrist Length (No. 3).

No. 65. MENTON - SELLION LENGTH (586)

Menton - Vertex Length (No. 40) less

Sellion - Vertex Length (No. 38).



### ACKNOWLEDGEMENTS

The assistance given by Mr. R. E. Simpson, Royal Aircraft Establishment, Farnborough and the Staff of the Royal Air Force Institute of Aviation Medicine, Farnborough for the provision of the engineering drawings of the Measuring Rig, and other technical assistance at various times during the construction process are hereby gratefully acknowledged.

### REFERENCES

1. Sears, W. J., R. C. Hill, and P. H. R. Gill. Integration Laboratory - Methodologies for the Assessment of Aircrew Clothing and Equipment (unpublished data).
2. NASA Reference Publication, 1024. Anthropometric Source Book, 1978, Vols. I and II.
3. USAF Systems Command Anthropometric Data, USAF Flying Personnel, Total Series, 1967.
4. Bolton, C. B., M. Kenward, R. E. Simpson, and G. M. Turner. An Anthropometric Survey of 2000 RAF Aircrew, 1970/71. RAF IAM Report No. 531, June 1973.
5. DOD-HDBK-743 (Metric). Anthropometry of US Military Personnel, October 1980.

APPENDIX

TABLES OF MEASUREMENTS

TABLE A-1. ALPHABETICAL INDEX OF MEASUREMENTS

Name of Measurement	PAACE Ident No.	DOD-HDBK-743 Ident No.
ABDOMINAL EXTENSION TO WALL	27	1
ACROMION - ELBOW LENGTH	63	150
ACROMIAL HEIGHT (SITTING)	21	146
ANKLE CIRCUMFERENCE	16	4
BALL OF FOOT CIRCUMFERENCE	60	11
BI-DELTOID BREADTH	23	148
BI-OCULAR BREADTH	45	19
BI-TRAGION BREADTH	44	20
BI-TRAGION CORONAL ARC	50	21
BI-ZYGOMATIC BREADTH	46	60
BUTTOCK CIRCUMFERENCE	11	94
BUTTOCK - HEEL LENGTH	17	NA
BUTTOCK - KNEE LENGTH	30	31
CALF CIRCUMFERENCE	15	33
CERVICALE HEIGHT (SITTING)	18	NA
CHEST CIRCUMFERENCE	8	37
CHEST DEPTH	26	38
CROTCH HEIGHT	6	42
ELBOW - FINGERTIP LENGTH	2	53
ELBOW FULLY BENT CIRCUMFERENCE	9	NA
ELBOW REST HEIGHT	22	57
ELBOW - WRIST LENGTH	3	58
EYE HEIGHT (SITTING)	61	59
FACE BREADTH	46	60
FINGER LENGTH (DIGIT 3)	55	NA

TABLE A-1. ALPHABETICAL INDEX OF MEASUREMENTS (cont'd.)

Name of Measurement	PAACE Ident No.	DOD-HDBK-743 Ident No.
FOOT BREADTH	59	65
FOOT CIRCUMFERENCE	60	11
FOOT LENGTH	58	66
FOREFINGER LENGTH	54	NA
FUNCTIONAL REACH (SITTING)	25	70
GLABELLA - VERTEX LENGTH	35	73
GLABELLA - WALL LENGTH	36	72
HAND BREADTH	53	77
HAND CIRCUMFERENCE	57	79
HAND LENGTH	64	81
HEAD BREADTH	43	83
HEAD CIRCUMFERENCE	49	84
HEAD LENGTH	36	72
HIP BREADTH	32	91
KNEE FULLY BENT CIRCUMFERENCE	13	NA
KNEE HEIGHT	29	106
LIP LENGTH	47	126
LOWER THIGH CIRCUMFERENCE	14	113
MAXIMUM HEAD DIAGONAL	42	85
MIDSHOULDER HEIGHT (SITTING)	20	NA
MENTON - SELLION LENGTH	65	61
MENTON - VERTEX LENGTH	40	118
MENTON - WALL LENGTH	41	117
NASION - VERTEX	38	145
NASION - WALL	39	144
NECK CIRCUMFERENCE	52	130

TABLE A-1. ALPHABETICAL INDEX OF MEASUREMENTS (cont'd.)

Name of Measurement	PAACE Ident No.	DOD-HDBK-743 Ident No.
NECK LENGTH (DERIVED)	62	NA
NECK LENGTH (POSTERIOR)	51	138
POSTERIOR NECK LENGTH	51	138
PUPIL - VERTEX LENGTH	37	50
SELLION - VERTEX LENGTH	38	145
SELLION - WALL LENGTH	39	144
SHOULDER HEIGHT (SITTING)	20	NA
SITTING EYE HEIGHT	61	59
SITTING HEIGHT	19	153
STATURE	4	159
STOMACH DEPTH	27	1
STOOL HEIGHT	31	NA
THIGH CIRCUMFERENCE	12	177
THIGH CIRCUMFERENCE (LOWER)	14	113
THIGH CLEARANCE HEIGHT	28	169
TRAGION - VERTEX LENGTH	33	NA
TRAGION - WALL LENGTH	34	172
UPPER ARM LENGTH	63	150
VERTICAL FUNCTIONAL REACH (SITTING)	24	NA
VERTICAL TRUNK CIRCUMFERENCE	7	180
WAIST CIRCUMFERENCE	10	183
WAIST HEIGHT	5	186
WEIGHT	1	189
WRIST CIRCUMFERENCE	56	191

TABLE A-2. NUMERICAL INDEX OF MEASUREMENTS

PAACE No.	Measurement Name	NASA No.
Standing		
1.	Weight	957
2.	Elbow - Fingertip Length	319
3.	Elbow - Wrist Length	324
4.	Stature	805
5.	Waist Height	949
6.	Crotch Height	249
7.	Vertical Trunk Circumference	916
8.	Chest Circumference	230
9.	Elbow Fully Bent Circumference	301
10.	Waist Circumference	931
11.	Buttock Circumference	178
12.	Thigh Circumference	852
13.	Knee Fully Bent Circumference	516
14.	Lower Thigh Circumference	561
15.	Calf Circumference	207
16.	Ankle Circumference	058
Sitting		
17.	Buttock - Heel Length	191
18.	Cervicale Height	220
19.	Sitting Height	758
20.	Midshoulder Height	612
21.	Acromial Height	025
22.	Elbow Rest Height	312

TABLE A-2. NUMERICAL INDEX OF MEASUREMENTS (cont'd.)

PAACE No.	Measurement Name	NASA No.
23.	Bi-Deltoid Breadth	122
24.	Vertical Functional Reach	914
25.	Functional Reach	867
26.	Chest Depth	236
27.	Abdominal Extension-Wall (Stomach Depth)	021
28.	Thigh Clearance Height	856
29.	Knee Height	529
30.	Buttock - Knee Length	194
31.	Stool Height	816
32.	Hip Breadth	459
Head/Neck		
33.	Tragion - Vertex	882
34.	Tragion - Wall	884
35.	Glabella - Vertex	389
36.	Glabella - Wall	391
37.	Pupil - Vertex	289
38.	Sellion - Vertex	739
39.	Sellion - Wall	741
40.	Menton - Vertex	595
41.	Menton - Wall	597
42.	Maximum Head Diagonal (Menton-Occiput)	437
43.	Head Breadth	427
44.	Bi-Tragion Breadth	142
45.	Bi-Ocular Breadth	138
46.	Bi-Zygomatic Breadth (Face Breadth)	165

TABLE A-2. NUMERICAL INDEX OF MEASUREMENTS (cont'd.)

PAACE No.	Measurement Name	NASA No.
47.	Lip Length	547
48.	Menton - Sub-Nasale Length	592
49.	Head Circumference	430
50.	Bi-Tragion Coronal Arc	144
51.	Posterior Neck Length	686
52.	Neck Circumference	639
Hands/Feet		
53.	Hand Breadth	411
54.	Forefinger Length	345
55.	Finger Length, Digit 3	346
56.	Wrist Circumference	967
57.	Hand Circumference	416
58.	Foot Length	362
59.	Foot Breadth	356
60.	Ball of Foot Circumference	397
Derived Measures		
61.	Eye Height, Sitting	330
62.	Neck Length (Cervicale - Tragion)	222
63.	Upper Arm Length (Acromion - Elbow)	751
64.	Hand Length	420
65.	Menton - Sellion Length	586



END  
DTIC

9-86